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GEOLOGICAL REPORT.

1879–1880.

FROM THE SECOND ANNUAL REPORT OF THE
BUREAU OF STATISTICS AND GEOLOGY.

JOHN COLLETT,

Chief of Department.

INDIANAPOLIS:
CARLON & HOLLENBECK, PRINTERS AND BINDERS.
1881.

Two thousand extra copies ordered printed by concurrent resolution of the Senate and House of Representatives, February 26, 1881.

55.

297377

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GEOLOGICAL REPORT.

In section 9 of the law establishing the Department of Statistics and Geology (approved March 29, 1879,) will be found the following provision: "The act approved March 5, 1869, establishing a separate department of geology, and the acts amendatory thereof, and in conflict herewith, are hereby repealed." The words "and in conflict herewith," as interpreted by the Supreme Court, constitute a retaining clause, and transfer all of the duties heretofore discharged by the State Geologist to the head of the new Bureau, except where a conflict between the old and new law is apparent. The duties thus transferred were "the collection and dissemination of information in relation to geological and other scientific investigations to be made for the promotion of agriculture, mining, the arts and manufactures," and also the collection, proper labeling and arranging of specimens of the ores, coals, building stones, clays, soils, organic remains, etc., of the State of Indiana. The appropriation for the State Geologist, under the act constituting his office, was at first five thousand dollars per annum, and was afterwards increased to eight thousand dollars per annum.

The Bureau of Statistics and Geology received an appropriation which placed at its disposal less than one-half the amount of funds voted to the Department of Geology during the last years of its existence; and under the belief that many of the provisions of the act of 1879 imperatively directed that especial attention be given to statistical matters of grave importance, the Bureau has, to a very considerable extent, devoted its time, funds and resources to statistical research and tabulation. The chief of the Bureau has, however, in addition to the general direction of the affairs of the Department, given as much attention as was practicable to matters pertaining to the geological division, by furnishing information, opinions and advice, written and oral, upon a multitude of subjects, and also making a few field investigations.

Reports of these investigations, which were of course limited by the time and funds at the disposal of the Bureau, are appended, as also some notes on stone and cement, and descriptions of a few of the mounds of Greene and Knox counties.

Mr. George K. Greene has made a survey of Monroe county, and his report, which is characterized by careful and minute details, gives a good description of the rocky formations of that county.

A "Synopsis of the Molluscous Fauna of Indiana," by Dr. F. Stein, gives the habitat or locality of these interesting natives of our State. His paper comprises the results of years of industrious study and patient research, and will prove to be of great value to students and teachers.

Professor C. A. White, of the Smithsonian Institution, late State Geologist of Iowa, and paleontologist for some of the most important government expeditions, has, without charge, and as a free contribution to science, prepared a clear and able description of Indiana fossils, in the introduction to which he has also given some most important suggestions concerning the value and methods of scientific study. This contribution to our knowledge of Indiana geology will be at once highly appreciated by the one hundred thousand teachers and students of the State who desire information on the subject, but are utterly unable to obtain the rare and high priced reports, through which alone, such information has heretofore been attainable.

Professor White's description of Indiana fossils will save to the students of the State many times the cost of the preparation of this report, and will enable our people to recognize and identify the fossils discovered in their own neighborhood, and in this way determine its geological position. The characteristic fossils of the different groups were selected for comment, so that the report might serve as an elementary effort, at once giving our students a reliable introduction to a knowledge of the rocks of the State, the description of new and rare specimens being left to future reports.

The illustrations of Prof. White's paper are the work of Dr. J. C. McConnell, one of the draughtsmen of the Smithsonian Institution. They are drawn in ink, and engraved by the new photo-engraving process and are of a high order of merit, representing the various fossils with almost mathematical correctness.

EXPENDITURES.

The expenditures for the geological work of the Bureau during the year 1879–1880, have been as follows:

Traveling expenses of Chief of Bureau	$65 00
Survey of Monroe county, Mr. Greene	150 00
Surveys in other districts, Mr. Greene	15 00
Drawing figures for Prof. White's paper, Mr. McConnell	180 00
Drawing maps, Mr. Morrison	20 00

Synopsis of Mollusca, Dr. Stein	$25 00
Increase of cabinet	50 00
Total	$505 00

THE STATE MUSEUM.

From the report of G. K. Greene (pp. 34-35) it will be seen that specimens belonging to the State, numbering in all 8,912 pieces, were found in the State Museum and transferred by the State Board of Agriculture to the care of the Bureau, pursuant to the decision of the Attorney General. At least one-half of these specimens have been labelled and arranged in cases, at a cost to date of less than $500. This expense has been defrayed from the balance of the geological funds in the hands of the State Board of Agriculture. The additions made to the State Museum by this Bureau have numbered 11,649 pieces, most of them being rare and perfect specimens. Of these 10,268 were added by purchase and the remainder by collection and donation. The State should, as soon as possible, become possessed of a complete cabinet of specimens of the fossils, rocks, building stones, and other materials of scientific and economic importance which are to be found within its bounds, and such collection should be easily accessible to the citizens of Indiana, and to visitors from other States. No cheaper or more striking exhibit could be made of her vast and varied resources and no more effective invitation or encouragement could be given to new industries for the investment of capital, than by a carefully arranged and neat display of the abundance of valuable materials now comparatively unused, with authoritative statements as to their extent, locality, cost and availability. The Bureau has felt this to be part of its duty, and has engaged in this department of work as far as the scanty means at its disposal permitted.

The experience of former State Geologists has always been that the publication of reliable statements as to the building materials and minerals of Indiana has called into existence mining enterprises, manufactories and railways almost without number, and within the last year this Bureau has been directly instrumental in the sale of Indiana stone, lime, etc, of the value of more than $100,000, to fill orders which would otherwise have been sent out of the State. Not less important is it that there should be some competent and reliable authority available for citizens to advise with as to mineral enterprises within the boundaries of the State, as is shown by the fact that almost every week some of our citizens are found advocating mining projects which a geologist can readily tell them are wild and useless. A competent Geological Bureau, as has heretofore been proved, can, by preventing unwise speculations save to the individual citizens of the State not less than from $25,000 to $50,000 annually.

THE NEEDED APPROPRIATION.

To continue geological surveys in the different counties of the State, and to publish further illustrations of the fossils of Indiana, with expert paleontological descriptions, will require a fair and reasonable appropriation, say from $5,000 to $6,000 annually; and for $1,000 a year in addition, the State Museum could, in a few years, be made so full and complete as to furnish each of the colleges and universities of the State with a cabinet of characteristic Indiana fossils sufficient for ordinary educational purposes. To insure thorough and efficient work in the Statistical Department (for report of which see pages 16 and 17, and 20 to 26 of preceding report) it will be proper that at least half as much as our sister States have spent should be allotted; and it is therefore advisable in the opinion of the Chief of the Bureau that the annual appropriation for the next two years should be as follows:

For the Division of Statistics	$6,000 00
" " " " Geology	5,000 00
For increase of State Museum	1,000 00
Total appropriations	$12,000 00

With such an appropriation the work could be done thoroughly in each department, and Indiana would thus take her stand along side of New York, Massachusetts, Kansas and all of the advanced States of the Union and the world. With less or a meager appropriation the work will fall short, and can not but do injustice to the intelligence and energy of our people, as well as to the grand natural resources of the rich soil and the minerals and building materials so freely given to Indiana.

GEOLOGY OF INDIANA.

The outline geological map of the State, printed herewith, is upon so small a scale that it must be regarded as merely a rough sketch. It shows, however, with reasonable accuracy, the surface exposures of the rocks of the several geoligical formations. An extended description of each of the general strata with a section illustrating the same might have been advantageously added to the present report, but the time and resources of the Bureau were so limited as to permit of only the following brief statement, embracing a list of the counties in which the several strata are found.

LOWER SILURIAN.

The rocks of the lower silurian age, known as the Hudson river or Cincinnati group, are found in the southeastern division of the State, extending also throughout large areas in Ohio and Kentucky. They are well exposed in the bluffs of the Ohio river, extending west to the mouth of Fourteen-mile creek, in Clark county, and form the surface rocks in the counties of Wayne, Union, Fayette, Franklin, Dearborn, Ohio, and Switzerland. In several of the adjoining counties to the west are exposures of lower silurian in ravines and deep cuts, as on the extreme east side of Clark, Jefferson, Decatur, Rush, and in the northern part of Randolph counties. The rocks of this formation are filled with well-preserved fossils, and in decomposition form a rich and highly productive soil.

UPPER SILURIAN.

Strata of the upper Silurian formation form the general surface rocks of the counties immediately west and northwest of those in the lower Silurian, including Adams, Wells, Washington, Wabash, Miami, part of Cass, Jay, Blackford, Grant, part of Howard, Delaware, Madison, the eastern parts of Tipton and Hamilton, Randolph, Henry, Hancock, Rush, Shelby, Decatur, the eastern part of Marion, Bartholomew, Jennings, Jefferson and the eastern parts of Scott and Clark counties. The upper Silurian strata also extends north and northwest from these counties to the northern boundary of the State, at many points being locally capped by uneroded areas of Devonian age, but the Silurian is so deeply covered with bowlder drift as to be rarely seen, and its presence is more known by test bores than by outcrops in the drift district.

Soils derived from the disintegration of rocks of this age are, as a rule, cold, heavy clays, which, when drained, produce good crops of wheat and the grasses.

DEVONIAN FORMATION.

The Devonian rocks are exposed in a narrow band commencing on the south of the central parts of Clark and Floyd counties and extend thence north and west through the counties of Scott, Jackson, Bartholomew, Johnson, Marion, Boone, Clinton and Carroll, with local exposures in Tippecanoe, Cass, White and Jasper. From fossils collected in the drift area to the north and west and from test bores, it is known that Devonian rocks have been more or less eroded, but once covered much of the northern third of the State, and at many points they are still in place.

SUB-CARBONIFEROUS OR MOUNTAIN LIMESTONE.

Rocks of the sub-carboniferous series form the surface strata in a wood belt west of the Devonian and east of the coal measures, and these, for the most part, constitute the rocky exposures of the counties of Harrison, Crawford, Orange, Washington, Lawrence, Brown, Monroe, Owen, Morgan, Putnam, Hendricks, Montgomery, Tippecanoe and Benton. The eastern line of this belt is composed of slates and sandstones of the Knobstone group, while adjoining on the west are the great cavernous limestones of the State, so well exhibited in the southern counties, but which thin out to a few feet at the north. The soil of this district is remarkable for its growth of cereals and grasses.

THE COAL MEASURES.

The rocks of the coal measures are found in the counties of Posey, Vanderburgh, Warrick and Spencer, the western parts of Perry and Crawford, in Gibson, Pike, Dubois, Knox, Daviess, Martin, Sullivan, Greene and Clay, the western part of Owen, and in Vigo, Parke, Vermillion, Fountain and Warren.

It is apparent, therefore, that the lower Silurian, being the oldest rocks brought to the surface, underlie all the more recent rocks which in succession have been deposited during the different ages of the earth's existence. A shaft or bore put down in the western part of Gibson county would pierce in succession all the geological formations of the State, and would show the approximate depth of each to be as follows:

GENERAL SECTION.

Coal Measures	725	feet.
Sub-Carboniferous	680	"
Devonian	200	"
Silurian	3,000	"
	4,605.	

OOLITIC LIMESTONE.

The excellent and abundant building stones of Indiana have been minutely described and discussed in former reports of the State Geologist, especially in that of Professor Cox, 1878. Demands have, however, been so continually made upon this office for information as to the quality, quantity and uses of the oolitic limestone that a short description, prepared in answer to one of these inquiries, is inserted in this report, as follows:

DEPARTMENT OF STATISTICS AND GEOLOGY,
INDIANAPOLIS, IND., May 13, 1879.

SIR:—In answer to the questions as to the comparative character and quality of the samples of Indiana oolitic limestone submitted for examination, I would say that in structures which, from their extent and use, must be permanent and substantial, such as bridges, court houses, State capitols and other public edifices, the duty imperative on those having direction is to carefully inspect and select such material as will, without the possibility of a doubt, resist the action of climatic conditions, as moisture, heat and cold, and gases existing, or that may hereafter exist, in the atmosphere; also such materials as do not contain within themselves elements which, on exposure, will result in chemical decomposition or disintegration This duty is absolute, and may not be neglected without disgrace and dishonor, yet it is well known that in many of the most important structures of the world—temples, cathedrals, houses of parliament, State capitols and great bridges—imperfect materials, through ignorance or selfish motives, have been used, and which are now going rapidly to decay, and will require the outlay of large sums of money to repair.

Stones have been used which, fresh from the quarry, presented a good appearance, and were, from mechanical tests alone, believed to be enduring, yet, on exposure for a considerable time, decay and fail, in many cases because the particles are not thoroughly cemented, as in soft sandstones.

Aluminous limestones are generally rigid and without elasticity to compensate for changes of temperature from the extreme heat of summer to the intense cold of winter. In such cases cleavage and cross-fractures, after a few years, break the stone to fragments.

Again, many quarries furnish magnesian limestones of good appearance, and which have been extensively used, but after an exposure of a few years show in spots manifest evidences of decay.

"Where bituminous coals are used the atmosphere becomes charged with sulphurous acid gas, and this is changed to sulphuric acid, which exerts a very marked influence upon magnesian stones by converting the carbonate into sulphate of magnesia (epsom salts), which is readily soluble in water, and is washed out by rains to stain and disfigure and finally destroy the cohesion of the stone. Magnesian limestones vary in their composition as regards the proportions of clay, carbonate of lime and carbonate of magnesia which enter in their composition, and should be carefully and elaborately tested before use."

The quarry at Bedford, Ind. is on the Oolitic or quarry bed of the St. Louis group of the sub-carboniferous period. Samples tested by Gen. Q. A. Gillmore, U. S. Engineer Corps, gave as its crushing strength 11,750 pounds per square inch; weight of a cubic foot, 146.56 pounds; and ratio of absorbtion 1 to 28.

An analysis of samples of stone from these quarries, made by Dr. G. M. Levette, chemist of the geological survey of Indiana, gave the following:

	Gray or light-colored stone.
Water expelled at 212° F	0.35
Insoluble silicates	0.50
Ferric oxide and alumina	0.98
Lime	54.10
Magnesia	0.13
Carbonic acid	42.62
Sulphuric acid	0.31
Chlorides of alkalies	0.40
Combined water	0.61
	100.00

Lime and carbonic acid combined give carbonate of lime 96.60.

As may be readily seen from the above table, this stone is an almost perfectly pure limestone, averaging over 96 per cent of carbonate of lime, a degree of purity rarely, if ever, surpassed. and equalled by very few of the most famous quarries of the world.

The stone crops out with bold, perpendicular faces, which record the standpoints of streams through the long ages during which they have been engaged in hewing out of solid rock their deep valleys; even back of this the striæ and erosions of the glacial age are seen, dating back to the beginning of quaternary time, supposed by many to have been several hundred thousand years ago. This stone has withstood the elements and their disintegrating action during these long periods, and will fully answer the requirements for permanent structures. The strata are from ten to twenty feet thick, homogeneous and of similar appearance in horizontal or vertical section, comes soft from the quarry, and is easily sawed; but, being tough under the chisel, it may be carved with facility and rapidity into any desired ornamental forms.

Cement should not be used in connection with this stone, in face work, but lime used instead.

This stone may be confidently recommended for the erection of extensive and permanent structures.

JOHN COLLETT.

Extensive beds of stone, similar or identical in quality to the samples described in the foregoing letter, are found and quarried in the counties of Owen, Monroe, Lawrence, Washington, Harrison and Crawford. By means of the lately adopted steam channeller and derricks for quarrying, the facilities for work are greatly enlarged and the labor so much modified that blocks of any size that can be transported by railways are readily obtained so as to be offered at cheap rates. This stone has been used in the construction of many court houses in the State, including that at the State capital, and also in the United States postoffices at Louisville and Indianapolis, in the city hall, Chicago, Ill., and exclusively in the carved capitals and exposed parts of the Illinois State House. The commissioners chosen to superintend the erection of the new State House at Indianapolis, after a series of exhaustive tests and experiments, have selected this stone over all competing specimens from the leading quarries of the United States, as the cheapest and most enduring and also as the least liable to discoloration in a coal smoke atmosphere.

This stone has been used with good effect for interior ornamentation in some of the palatial residences of New York and other eastern cities.

Additional beds of snow white limestone have heretofore been reported, in the counties of Harrison and Crawford, which, when made accessible to Ohio river steamers by tram or railways, will prove a very desirable material for ornamental work, as it is a remarkably pure stone and of excellent quality.

PORTLAND CEMENT.

The ordinary hydraulic lime or Roman cement is made from native rocks, some times from those of a single bed, or else from many layers from different beds, mingled in a kiln.

Portland cement is artificial and is made up of materials from a variety of deposits, which, having been carefully proportioned, are manipulated and burned.

The hydraulic limes of Indiana were considered and described at length in the Geological report of 1878, and an analysis of foreign specimens was given for purposes of comparison. During last year a company was organized at South Bend, which has since been engaged in the manufacture of Portland cement from the gray clays and calcareous marls found along the shores of the ancient lakes of St. Joseph County.

Analyses of the marl and clay used at South Bend and also of the Roman and Portland cements manufactured by this new company are given below as reported by Chemical Assistant John Hurty; the tests for compression being those made officially and carefully, and exhaustively conducted by Mr. F. W. Vogdes, Superintendent of the new State House.

ANALYSIS OF CEMENT CLAY, SOUTH BEND, IND.

Moisture	0.575	per cent.
Carbonic acid gas	14.500	" "
Silica and insoluble earthy matter	59.133	" "
Ferric oxide	1.923	" "
Alumina	1.333	" "
Magnesia	4.130	" "
Chlorides of potassium and sodium	0.478	" "
Lime	12.208	" "
Organic matter—loss by ignition	4.875	" "
	99.155	

ANALYSIS OF CEMENT MARL, SOUTH BEND, IND.

Moisture	0.250	per cent.
Carbonic acid gas	41.900	" "
Silica and insoluble earthy matter	0.233	" "
Ferric Oxide	0.166	" "
Alumina	0.185	" "
Magnesia	3.100	" "
Chlorides of potassium and sodium	0.301	" "
Lime	48.963	" "
Organic matter—loss by ignition	4.350	" "
	99.448	

ANALYSIS OF SECOND SPECIMEN OF MARL FROM SOUTH BEND CEMENT WORKS.

Moisture	14.779	per cent.
Organic matter (by ignition)	1.675	" "
Sand	3.400	" "
Carbon-di-oxide $C. O_2$	35.260	" "
Lime	43.250	" "
Magnesia	1.126	" "

Alumina	0.207	per cent.
Iron Oxide	0.134	" "
Chlorine	trace.	
	99.831	

ANALYSIS OF SOUTH BEND COMPANY'S ROMAN CEMENT.

Moisture	0.500	per cent.
Carbonic acid gas	4.370	" "
Silica and insoluble earthy matter	23.400	" "
Ferric oxide	0.498	" "
Alumina	15.170	" "
Magnesia	10.270	" "
Chlorides of potassium and sodium	1.083	" "
Phosphoric acid	0.395	" "
Lime	40.600	" "
Organic matter (loss by ignition)	3.100	" "
	100.386	

ANALYSIS OF SOUTH BEND COMPANY'S PORTLAND CEMENT.

Moisture	0.150	per cent.
Carbonic acid gas	1.500	" "
Silica	22.400	" "
Ferric oxide	1.504	" "
Alumina	15.146	" "
Magnesia	4.320	" "
Chlorides of potassium and sodium	3.820	" "
Phosphoric acid	0.402	" "
Lime	48.630	" "
Organic matter (loss by ignition)	1.450	" "
	99.322	

F. W. VOGDES' TESTS.

OFFICE OF SUPERINTENDENT OF NEW STATE HOUSE,
INDIANAPOLIS, November 5, 1880.

Tests of South Bend Portland Cement, manufactured at South Bend, Indiana:

Tension per square inch.		*Compression per square inch.*	
One day in air.			
56 lbs.		265 lbs.	
58 "		245 "	
52 "		235 "	
51 "		265 "	
57 "		235 "	
Total, 274	Average, 54 4-5 lbs.	1245	Average 249 lbs.

	Tension per square inch.		*Compression per square inch.*	
	Four days' exposure.			
	170 lbs.		900 lbs.	
	140 "		1025 "	
	165 "		900 "	
	169 "		990 "	
	179 "		1060 "	
Total,	823	Average, 164 3-5 lbs.	4875	Average, 975.
	One hundred and seventy-three days' exposure.			
	216 lbs.		1500 lbs.	
	240 "		1400 "	
	246 "		1300 "	
	218 "		1367 "	
	215 "		1500 "	
Total,	1135	Average, 227 lbs.	7167	Average 1433 2-5 lbs.
	One hundred and ninety-four days' exposure.			
	297 lbs.			
	288 "			
	260 "			
	321 "			
	266 "			
	1432	Average, 286 2-5		

NOTE.—The capacity of our crushing apparatus is only 1500 lbs., and specimens showing 1500 lbs. were removed unbroken.

Signed, F. W. VOGDES, *Sup't.*

Superintendent Vogdes, whose reputation as a skillful architect and builder, is so well known, adds in explanation of the above, that "no attempt was made to develop the full strength of any brand of cement tested, but only to ascertain what strength might certainly be relied on, when the cement is used by inexperienced and thoughtless workmen, and under the disadvantagous circumstances constantly arising during the progress of a building."

The above tables show that in the manufacture of hydraulic cement, much greater strength and usefulness is attained if the component parts, even when they are nothing but the usual ingredients, are properly combined; and the tests, also, afford convincing proof that here in Indiana is made a Portland cement fairly rivaling the best foreign brands.

The citizens of the State may well be proud of the success attained, as there is a large and constantly increasing consumption of good Portland cement. The same company is also engaged in the manufacture of stone pipes, tubes, and architectural ornaments of great strength and beauty.

INDIANA BLOCK COAL VERSUS PITTSBURG COAL.

During the past year the managers of the State benevolent institutions in this city had under consideration proposals for the supply of a large amount of coal for heating purposes, and before any contract was made, President Fishback, of the Board of Trustees, addressed to this office a letter of inquiry as to the relative merits of the Indiana block coal and Pittsburg coal, which elicited the following reply:

Department of Statistics and Geology,
Indianapolis, Ind, August 26, 1879.

Hon. John Fishback, President Board Benevolent Institutions:

Sir: Your favor, dated August 29, (?) received a few days since, asking—

1. "Which are the more economical coals for generating steam — Pittsburg or block coals? (Of course the general relative prices should be considered.")
2. "Which of the block coals are the best?"
3. "Will the block coals stand the winter weather as well as the Pittsburg coal?"

In answer I will say—

1. That an analysis of a good specimen of the Pittsburg gas coal (Youghioghany) or its equivalent, and an average specimen of Indiana block coal, shows as follows:

Coals.	Fixed Carbon.	Gas.	Water.	Ash (white.)	Coke.	Specific grav.	Weight of cubic foot	Heat units.
*Indiana block coal..................	58.00	37.00	2.50	2.50	60.50	1,227	76.06	8080
†Best Pittsburg coal................	58.00	34.00	3.00	5.00	63.00	1,292	80.75	7505

* McRea Coal, Geological Report, 1875, page 72.
† Gas Works, Pittsburg coal, Geological Report, 1875, page 69.

According to above results of analysis by Prof Cox, Indiana block coal is a small per cent. superior in heat-producing qualities to the best Pittsburg coal; and the latter is 40 to 50 per cent. dearer in price, it is much more economical to use block coal for generating steam. Besides, block coal is so nearly free from sulphur that boilers and fire grates will last much longer, block coal being used.

2. The best block coal for generating steam is the second grade, or that which will not answer for smelting iron without coke.

3. Block coals will not stand winter "stocking" as well as Pittsburg coal, but when the edges of a heap are adjusted by setting up blocks, and the upper surface is covered to a depth of four inches with slack, the waste has been found by experience of dealers to be less than two per cent., or almost nothing.

Respectfully yours, John Collett,
Chief of Department.

The result of this correspondence was that "home industry" was encouraged by the use of the block coal during the winters of 1879–80, in addition to which several thousand dollars of expenditures were saved to the State. The comparative cost of the amounts for which contracts were made, was as follows:

INDIANA BLOCK COAL.

	Bushels.	Per bush.	Amount.
For Insane Asylum	100,000	6 9-10c	$6,900 00
For Deaf and Dumb.	15,000	8¾	1,312 00
For Blind Asylum	12,000	8½	1,020 00
Total	127,000	....	$9,232 00

PITTSBURGH COAL.

At the lowest bid offered was	127,000	14c	$17,780 00
Net saving to the State			$8,548 00

The Indiana block coal was also found so nearly free from sulphur and clinker that there was estimated to be an additional saving annually of 5 per cent. on the first cost of iron fire-boxes and flues exposed to the fire and flame.

A comparison of the temperature as taken heretofore when Pittsburgh coal was used, carefully measured and governed by thermometer, established the unquestioned economy and complete superiority of Indiana block coal.

HYPERION BURNING FLUID.

It became the duty of Mr. Hilary Clay, State Inspector of Carbon Illuminating Oils, in the course of his official investigations to examine a fluid bearing the above name.

He submitted samples to the Attorney-General with a request for an opinion as to his duties concerning the same, and the Attorney-General forwarded the samples to the office of this Bureau for examination in order to determine whether the products of petroleum were ingredients in the fluid.

The following letter gives the results of the examination:

Department of Statistics and Geology.
Indianapolis, Ind., Jan. 12, 1880.

Hon. T. W. Woollen, Attorney General of Indiana:

Sir:—The sample of burning fluid marked "*Hyperion*," submitted by Mr. H. Clay, State Inspector of Oils, has been examined

1. Physical characteristics, as odor, color, limpidity and smoky combustion, indicate products of petroleum

2. It is coagulated (thickened) by *saponaria officinalis*, a test authorized by the Journal of Chemistry.

At the suggestion of Prof. Wiley, of Purdue University, and with the assistance of Mr. John Hurly, Chemical Analyst, the fluid was subjected to the test directed by chemical text-books of *fractional distillation* with the following results.

(a) Vapors came over at 113° F. which were not condensed by ice water, indicating products lighter than gasoline.

(b) From 120° to 180° F. distillate amounted to 37 00 per cent., with specific gravity of 0.666, thus indicating gasoline.

(c) From 180° to 220° F. the distillate amount to 33.60 per cent,, with specific gravity of 0.698, indicating C. naptha mixed with gasoline.

(d) The residuum which did not evaporate at 220° F. was 29.40 per cent. of the whole with specific gravity of 0.73, indicating B. naptha with a small amount of A. naptha.

The following formula describing the products of petroleum, is from page 371, Vol. XIII, Appleton's Encyclopedia:

Articles.	Boiling Point.	Specific Gravity.
Gasoline	120° F.	0 665
C. Naptha	180° F.	0.706
B. Naptha	220° F.	0 724
A. Naptha	300° F.	0.742
Kerosene	350° F.	0.804

From the foregoing results and indications I am clearly of the opinion that products of petroleum are constituent elements in the sample examined for Inspector Clay

At my request chemical tests were made by Henry Jameson, M. D., Professor of Chemistry at the Indiana Medical College, with similar indications.

Glass bulbs partly filled with the fluid and hermetically sealed, were placed in water. As it approached the boiling point one exploded at 185° F., another at 191° without report; another bulb, as before, containing about 15 to 20 drops of the fluid, was exposed to the flame of a small amount of the fluid. It at once exploded violently with a report similar to that of a musket percussion cap.

As a result of this investigation the Inspector ordered that this highly inflammable and dangerous burning fluid should not be sold within the State, and no doubt many lives and much property have been saved by his thoughtful vigilance.

JOHN COLLETT,

Chief of Department.

THE MAMMOTH AND MASTODON.

REMAINS IN INDIANA AND ILLINOIS.

Remains of the mammoth have been discovered in nearly all sections of Indiana. They have consisted, as a rule, of the most compact bones of these animals as the teeth, tusks, jaws, and thigh bones. Up to this time the finding of parts of over twenty-five mammoths, *Elephas americanus*, has been reported, and the bones have generally been found in the southern or middle part of the State, imbedded in the close dark clays, deposited in the central deep eddies of the Lacustral epoch which followed the glacial period. Fresh water at that time covered much of the great valley of the continent; sluggish rivers were the channels of the rainfall, as the slow rivers of South America now maintain the mighty Amazon, and a tropical climate prevailed. In the same clays have been found the bones of *Megalonix jeffersoni*, *Casteroides ohioensis*, *Bison latifrons*, etc., all giants of wondrous power. Some of the best preserved teeth of the Mammoth were found in the counties of

Vigo, Parke, Vermillion, Wayne, Putnam and Vanderburgh, and all of them indicated a development of size and strength in the animals fully equal to the best Asiatic specimens.

The most recent discovery furnishes, perhaps, the most interesting and important specimen that has yet been attained, and it will be of significance to scientists, to learn the exact circumstances under which it was found. During the summer of 1880, on the farm of Mr. John H. Caylor, E. ½ N. E. ¼ Sec. 16, T. 18, R. 9 W., four miles southeast of Noblesville, Hamilton Co., a large ditch was being opened for the drainage of a morass, or swamp, which was situated in a valley twenty rods wide, and extending several miles from south-east to north, 10° west, indicating a sluiceway and furrows of the great ice-floe; and the fact that it crossed valleys formed by some of the actual streams and brooks indicated that the locality of the swamp had been a thoroughfare of the glacial age. The table land adjoining was glacial drift, and filled with many large bowlders and gravel. Its surface was generally level, but presented a mammalated appearance, with isolated knolls, succeeded by occasional bowls, or basin-shaped depressions from one hundred to four hundred feet long, running east and west, and of a width half or two-thirds as great north and south. The formation of the table-land seemed to indicate that it was the top glacial deposit, and to suggest by its inequality, the final thrust of the ice-floe. The ditch was four feet deep, three feet of the cut was through recent peat or bog, and the bottom was excavated in fine blue clay to the depth of one foot. In this was found mammoth bones consisting of two well preserved teeth, one hip and one thigh bone and the tips of two vertebrae. These were scattered along the line of the ditch in a space eighty feet long by less than two feet wide. They were broken, but not in such a manner as to show any signs of the wear of distant transportation, rather indicating conclusively that the monster animal had lived there, and that up to the time of their discovery his remains had rested in their original miry grave.

Of the thirty individual specimens of the remains of the Mastodon (*Mastodon giganteus*) found in this State, in almost every case a very considerable part of the skeleton of each animal proved to be in a greater or less condition of decay. The remains have always been discovered in marshes, ponds, or other miry places, indicating at once the cause of the death of the animal and the reason of the preservation of the bones from decay. Spots of ground in this condition are found at the summit of the glacial drift or in "old beds" of rivers which have adopted a shorter route and lower level consequently their date does not reach beyond the most recent changes of the earth's surface; in fact, their existence was so late that the only query is why did they become extinct?

A skeleton was discovered in excavating the bed of the canal a few miles north of Covington, Fountain county, bedded in wet peat. The teeth were in good preservation, and Mr. Perrin Kent states that when the larger bones were split open the marrow, still preserved, was utilized by the bog cutters to "grease" their boots, and that chunks of sperm-like substance 2½ to 3 inches in diamater (*adipocere*) occupied the place of the kidney fat of the monster.

During the past summer of 1880 an almost complete skeleton of a mastodon was found six miles northwest from Hoopston, Iroquois county, Ill., which goes far to settle definitely that it was not only a recent animal, but that it survived until the life and vegetation of to-day prevailed. The tusks formed, each, a full quarter of a circle, were nine feet long, twenty-two inches in circumference at the base, and in their water-soaked condition weighed 175 pounds. The lower jaw was well preserved with a full set of magnificent teeth, and is nearly three feet long. The teeth, as usual, were thickly enameled, and weighed each from four to five pounds. The leg bones, when joined at the knee, made a total length of five and a half feet, indicating that the animal was not less than eleven feet high and from fifteen to sixteen feet from brow to rump.

On inspecting the remains closely, a mass of fibrous, bark-like material was found between the ribs, filling the place of the animal's stomach; when carefully separated it proved to be a crushed mass of herbs and grasses, similar to those which still grow in the vicinity. In the same bed of mirey clay a multitude of small fresh water and land shells were observed and collected, which were kindly determined by Dr. F. Stein, as follows:

1. *Pisidium,* closely resembling *P. abditum.* Halderman.
2. *Valvata tricarinata.* Say.
3. *Valvata,* resembling *V. striata.*
4. *Planorbis parvus.* Say.

These shell-bearing animals prevail all over the States of Illinois, Indiana, and parts of Michigan, and show conclusively that however other conditions may differ, that the animal and vegetable life, and consequently climate, are the same now as when this mastodon sunk in his grave of mire and clay.

ARCHÆOLOGY.

A VINCENNES MOUND.

When first visited by the white race about 1700, the "Great valley of the continent" was occupied by a peculiar race of savage Indians. Of one general type, the different nations were separate and alien or only connected or united by temporary alliances. Purely nomadic, migrations with or without seeming cause, were common. Consequently no fixed habitations were erected—no permanent towns or cities existed. The only gravitating love of locality or country was respect for the graves of their fathers. Governed by impulses or necessities of the moment or the chase, their homes were as changeable as the seasons. Industry was a disgrace except as it led to success in war or the chase. Without written language, the assembly heard the story of every exploit—the orator was the historian—memory the only record. Their traditions did not reach back to an earlier people or age.

But extensive earthworks and temple, sepulchral or house mounds, are found in this region, especially in the States of Ohio and Indiana, which required for their erection persistent labor for a long time under intelligent direction. Many of these works exhibit high engineering skill, as parallel walls, exact circles and squares, so repeated as to prove the knowledge and use of an adopted rule of measure. Other geometric lines drawn over hill and valley seem to require exact instruments.

There is no indication of such skill, industry or effort in the Indian race of wanderers.

These works, however, indicate a sedentary, agricultural people, partly civilized. That race has passed away. A total wreck on the stream of time without word or script to their successors, except the mute story of crania, implements and mounds. Hence the wisest of our country have carefully explored such earthworks and collected the implements of this ancient race, hoping to throw some light upon the habits, government and religion of the lost people. Much has been done—more remains to do.

Some account was given by the writer in Indiana Geological Report, 1873, of the numerous antiquities in Knox county. The sepulchral mounds show respect for their illustrious dead, and the lofty temple mounds seem to indicate the holy city of a race of devoted sun-worshippers.

The tumuli of this and adjoining counties have on their surface shallow, intrusive graves of the savages. At the base, remains of the ancient people, and in a few cases between them, the stone graves or vaults of another race! pointing to at least three successive peoples who have occupied these mounds.

During the past summer (August, 1880) the authorities of the city of Vincennes, Knox county, Indiana, by John Burke, Esq., chairman of committee, and John Knauf, commissioner of streets, had occasion to complete the grading of Locust street. An ancient mound extending across the foot of this street and within three hundred and fifty feet of low water in the Wabash river was an obstruction, and its removal found necessary. The mound was ninety feet in diameter, and the greatest height in the center was four feet ten inches, with a gradual slope to the circumference.

The excavation was begun on the south side, with plow and scraper; in approximating the ancient surface of the plain which is a bed of modified glacial and fluviatile drift, an elliptical area eight feet in diameter was noticed presenting a fat black earth. This was carefully explored by the superintendent, and beneath was discovered an ancient *ossuary* or vault grave containing the skeletons, more or less decayed, closely packed and somewhat cemented together, of not less than thirty to fifty human beings. The bones were clustered pell-mell, heads, feet and fingers irregularly in contact with the larger bones. The only approach to arrangement was, that a few more, skulls were placed along the south and east borders of the pit; otherwise the remains were so crossed and mixed as to show that they were entirely disjointed; that it was a tomb of dry bones, not of bodies. These had been placed in the form of a sharp cone, but by compression and decay, now exhibited a thickness of six inches at the center, thinning down to a few scattered fragments at the edge of the circle. The vault or grave had been dug a depth of two feet in the surface of the earth, the interior smoothed with a coating of white plaster made from calcined mussel shells; the remains placed in the receptacle, and the exterior surface plastered, as the interior, with a coating one quarter of an inch thick. Over this was carefully placed a thick covering of black bituminous shale from the bed of "Turkey" or "Snap's" creek, a neighboring brook to the north, which, in its decay, made the remarkable deposit of "fat" "black" earth which originally commanded attention. The upper part was built up of clayey loam.

Many of the larger bones were nearly whole, and presented their surface outlines perfect. They showed no evidence of cutting or splitting, nor had they been baked, roasted or burned. These people were not cannibals, but had reverently gathered their dead, at some stated epoch, as mentioned in

"Jones' Southern Indians," and with solemn mourning re-united their departed friends, in a single grave, with national funeral honors.

At the center of the bottom of the vault, the first deposit in this grave was found a clustered sheaf of wing-bones of the wild turkey, one-fourth of an inch in diameter, and four and a half to five inches long, thirty-five to forty in number. The body or larger ends of these were all in one direction; the other end sharpened or beveled, and one side cut away, like the immense number of similar articles found in the ancient grave pits at Madisonville, Ohio. It is possible, if not probable, that they were so deposited in the center of this national grave, bound with cloth and bands, as a record of the number of dead here resting. With these were found three bear's tusks or teeth, with small holes drilled through the points, showing that some gallant warrior or hunter had been allowed to sleep his last sleep honored with a necklace of pendants,—trophies of the chase.

These *Ossuaries* and mounds of final burial are a common feature in the later mounds of this and adjoining counties. At several points mounds have been opened containing two or three vaults, built successively over each other, the first or lowest containing only two or three skeletons, the second ten or fifteen, and the upper one, as the nation had increased in numbers, containing twenty to fifty or more. A single vault, removed from Mr. Coffey's grounds at Spencer, Owen county, contained twenty-five wagon loads, or over six hundred bushels of human skeletons, representing fifteen hundred or possibly two thousand individuals. These vaulted mounds seem to indicate a race which succeeded the original Mound Builders, conquering and expelling the old race, and, as is always the rule in cases of conquest, adopting, in part, the civilization of their subjects and captives.

After tradition of this grave was lost, a tribe—perhaps a strange people—had built their communal house mound upon the north side, and partly overlying the vault. It was of later date and intrusive upon the ancient remains, and so recent that the river shells would not indicate a greater age than from four to six hundred years, while the more ancient vault might date back to eight hundred or one thousand years ago. This intrusive habitation had long been occupied, for beneath the fallen roof clays, were found successive beds of ashes from two to six inches thick, containing particles of charcoal and decayed shells of the Unio, Helix, and Paludina. At the river front of the mound two ground-stone foot-adzes, or gouges, were found, suitable for hollowing out and dressing the interior of canoes, troughs, etc., after they had been shaped by fire.

Vincennes was a favorite resort for all our ancient people. Without domestic animals or beasts of burden, they were compelled to rely on boats or canoes for transportation, and this locality offered the nearest spot, clearly above high water, to the confluence of White and Embarras rivers, with the Wabash, hence, easy of access it was a capital city, as indicated by numerous mounds of habitation as well as by the great Temple, Terraced and Pyramid Mounds described in Indiana's Geological Report, 1873.

THE WORTHINGTON MOUND.

One of the most interesting works of the "Mound Builders" is situated on the triangular space or "square" between Washington, Main and Union streets of Worthington, Greene county, Indiana, not for its size or symmetry, but for the extent of materials, and especially for the character of the relics found. It is situated upon a slight knoll, not more than two or three feet elevated above the general level of the alluvial deposit on which the town is situated. This prairie is the ancient flood plain or "delta" land at the confluence of White and Eel rivers, streams easily navigable for the canoes and pirogues of our predecessors, and well stocked with fish; the surrounding regions offer rich soil, native fruit, and fattening grasses to the buffalo, deer and other beasts of chase.

The mound, as well as can be now determined, was slightly elliptical, being 360 feet wide from north to south, and from 360 to 390 feet long from east to west; the extreme height of carried material at a point a little north east of the center, was nine feet six inches, sloping rapidly to the east, but with gradual incline north, south, and west. The carried material was a fine loam or clayey earth, brought from a neighboring marsh one quarter to half a mile north, so that the distinction between the artificial mound and the natural surface of clear fluviatile sand was easily apparent. This material amounted to nearly 4,000 cubic yards of earth—1,800 wagon loads; and as these people had none of the tools of our life, we may say 108,000 baskets full. Allowing that these workmen, or builders, would travel as far as an army under heavy marching orders, they would carry and deposit about one half a cubic yard per day to each man, or 8,000 days for one man. But considering that each man had to supply himself with food, and that he had to join in the dance and festivities common to barbarous people on ceremonial occasions, we may more safely estimate nine baskets full, or nine cubic feet of earth as a day's work; consequently it would require the labor of one man 12,000 days, or 200 persons full sixty days.

The outlook due east was up a valley piercing the eastern bluff of White river, giving the sleepless priest who guarded the ever burning fire upon his altar, such opportunity of catching the first rays of "sunrise" as was necessary in calling his people by chant and drum to their morning devotion and worship of the sun—the fountain of life, light and comfort.

Several years ago Mr. W. C. Andrews, in preparing for the erection of the old "Franklin House," excavated part of the east side and top of the mound. Near the central apex he found an elliptical vault eight feet long, five feet wide, and three feet deep, surrounded by a sandstone wall eighteen inches thick, with a narrow entrance at the south end and a minor elliptical chamber separated by a wall at the north extremity. The bottom was floored with thin slabs or flag-stones; it contained no bones or other relics, but the interior contents a "fat, black" earth, indicated the decomposed remains of a cover of black, bituminous shale from the roof of neighboring outcrops of coal, *A*. This vault was evidently not connected with, but intrusive upon the original work, after abandonment by the originators. It seems specially adapted for the purpose of a temporary receiving vault for bodies of those dying between the epochal national funerals. Such temporary vaults were noticed (Ind. Geol. Report, 1870), at Fort Azatlan, in Sullivan county and other places in this State. Its location was invited by the circular depression at the chimney top near the apex of their predecessors' edifices

In 1878, the town authorities of Worthington removed a considerable part from the north side of the mound, discovering none of the ancient remains, but exposing several intrusive Indian graves near the surface, but on the completion, March, 1880, of the Terre Haute and South Eastern Railroad to this point, it was necessary, in making a junction with the Indianapolis and Vincennes Railway, to fill up the abandoned bed of the W. & E. Canal along the track of the latter road. This was done under the direction of Mr. Calvin S. Taylor, by borrowing earth from the mound. Much credit is due Mr. Taylor for carefully observing the developments made, for sacredly preserving the few relics found, and for measurements here reported.

The following interior arrangements were observed: The surface soil had been stripped away to a depth of seven or eight inches, exposing a subsoil of compact, fine sand, which constituted the floor of the mound room. Near the center was a bed of ashes about ten inches deep, covering an area of ten to twelve feet square, in which were roasted bones of animals, spikes of deer horns, mussel and snail shells, charcoal and fragments of earthernware pots, indicating the kitchen fire of a large household. The disturbed nature of the earth above this fire-place, with a quantity of flat stones reddened by fire, seemed to indicate a chimney, or smoke flue, partly supported by rough masonry, which in the course of time had fallen in; black spots, or columns of black mould at the circumference of the mound and at interior points showed that trunks of trees had been utilized as posts, to support the earthern roof, which had entirely decayed.*

The floor of the building was covered with fragments of broken pottery, with a few stone or bone implements of household use. No warlike weapons were seen—it was a peaceful, agricultural people. The whole mound seemed to indicate the communal home of a large family or tribe, with a common roof, walls, fire, etc., a mode of life characteristic of many native nations and races.

Single human skeletons were found irregularly scattered near the circumference of a circle about sixty feet in diameter, having the ash pit for its center, but more numerous near the eastern doorway. The bones were badly decayed, and as a rule, went to dust after exposure; they would represent a possible fifteen to twenty individuals.

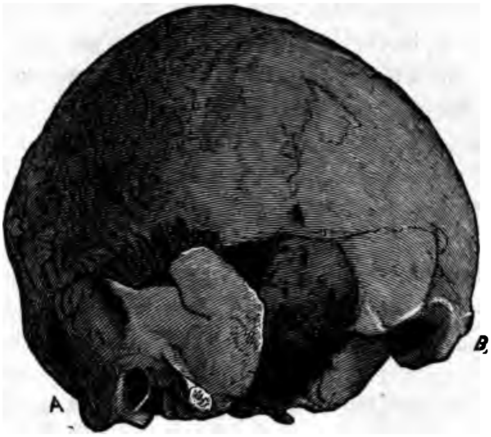

FIGURE A.

At once the question arises, what changed this residence or home of a tribe to a charnel house? A single circumstance throws a ray of light. On the northwestern arc of the circular corridor, or area, was found the skeleton of a man with household implements widely scattered about as if in ordinary use; the back part of his skull, shown in figure A, was crushed in by the blow of a large stone hammer from behind and below, or while reclining on his right side, making an opening and indentation in the occipital region 2½ by 3 inches in area. A murder had been committed; an unholy death had occurred beside the household altar, and probably by a law common to some American and Pacific island peoples, the house was thenceforward "taboo," unfit for occupation, and dedicated to the dead. The remains of others were then brought from temporary graves and here deposited in the national "dead house" for their last sleep.

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*Thousands of analagous natural columns of black earth were exposed in the cellar for the new State House at Indianapolis, discovering three successive forests, the stumps of which have been buried by the overflow deposits of the neighboring river, fairly showing the slow decay of trunks of trees, and the effort of nature to fill the vacuum made by decay with black mould carried by percolating rain water.

The articles found on the floor of the mound were:

1. Crania and human bones.
2. Ornamented vase.
3. Japanese image—head.

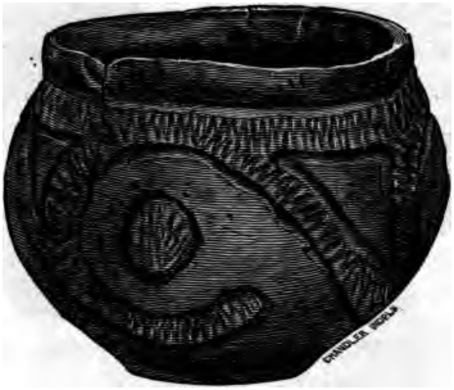

FIGURE B.

4. Japanese image—foot.
5. Bone whistle.
6. Copper axe.
7. Flint knives.
8. A smooth, symmetrical, oblong, spherical stone muller or pestle.
9. Flint chips, by abrasion, showing use.
10. Bone implement.

DESCRIPTION OF RELICS IN WORTHINGTON MOUND.

The principal bones of the murdered victim were preserved. The skull, Fig. A,* is of the typical pyramidal form characteristic of the early Mound Builders and gives the following measures:

Circumference from eyebrow to base of occiput.........	18.20	inches.
Frontal arc, from ear to ear..........	10.10	"
Arc over top " " " "	12.75	"

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*All figures of the relics, to insure absolute fidelity, are cut from photographs on wood.

The well closed satures and worn teeth, as examined by Dr. Brouillette, of Worthington, indicated his age to have been 55 or 60 years, and by measurement of the tibia his height when living was only 5 feet 4 inches. The high head showed an unreasoning man of great firmness and energy, and the projecting lower jaw a strong flesh eater. The cranium was abnormal or "lop-sided," by reason of superior size of the right over the left side, so that when erect the head would incline that way, and as a rule he would sleep lying on that side, as was probably the case when he was killed.

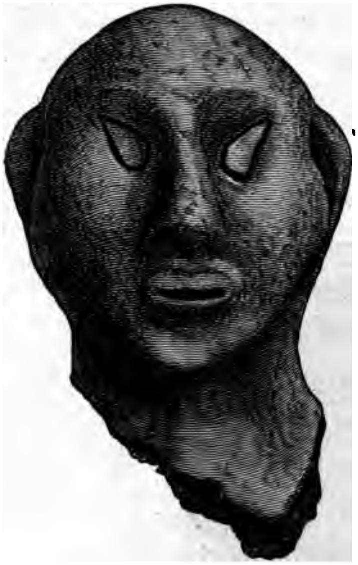

FIGURE C. FRONT VIEW.

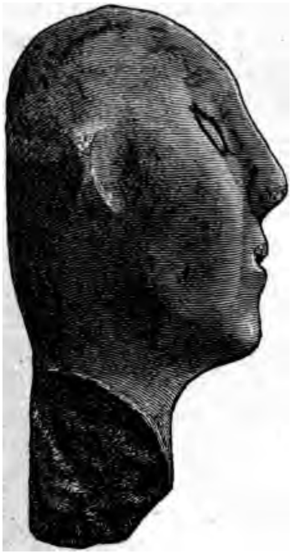

FIGURE C′. SIDE VIEW.

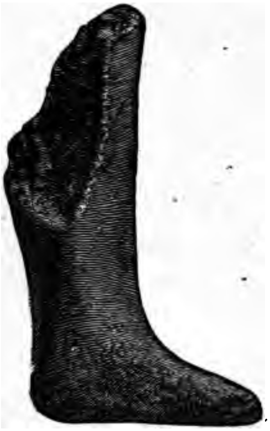

FIGURE C″.

The vase is ornamented by a peculiar fillet, with complementary pendant curves in symmetrical design and shows more skill than is usual in Mound Builders' pottery. It is the most artistic design accompanied by regular form, seen by the writer out of over a thousand specimens by him examined, and seems to indicate skill of a higher order than the careless efforts of an occasional workman. In other words, it exhibits the skill of a habitual mechanic trained by teachers as well as practice. The vase is shown in Fig. B.

The Japanese head and foot, Fig. C, was so peculiar as to awake doubts as to the genuineness of the find, hence an exhaustive inquiry was made, not only of those immediately engaged on the excavation, but of other citizens, calling in the aid of the well-known and successful detective, Mr. K. Osborn. The testimony of all united as to its authenticity. The superintendent, Mr. Calvin S. Taylor, reports that it was found by a boy employed on the excavation, about 60 feet N. N. W. from the hearthstone center, on the sand floor, 8 feet below the surface. When first removed from its bed it was soaked with the dampness of the earth and so softened that in brushing away the adhering dirt, the extremity of the nose and ball of the right eye were slightly abraded, as may be seen. The image was probably entire, but in the bustle of work with a full force of men and teams, only the head and one foot was preserved. A front and side view of the first is given Fig. C and C′. Of the latter a side view, Fig. C″.

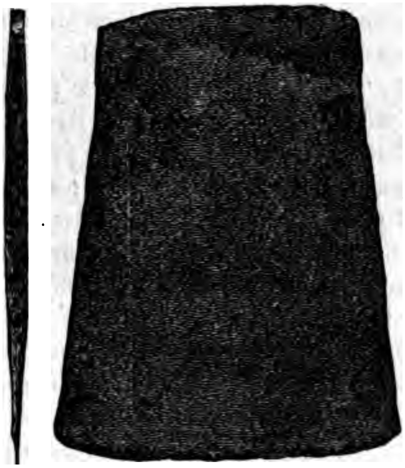

FIGURE D. COPPER AX.
Front and side view.

The head is a striking picture. No artist could conceive the image of an eagle or lion and fix it in pictured art, without seeing, or knowing of such animals. The physiognomy here given is as distinct from other races, as these animals are from other species. The most inventive genius could not join the almond eyes, high cheek bones, strong nose, pouting lips and flabby ears to an image, without seeing familiarly an original Japanese. Nor would he have done so unless the figure awoke either ideas of beauty, or respect for a superior from worthy qualities, as an ancestor, governor, teacher, or necessary protector. Mound pottery, as a rule is rude, inartistic and composed of a mixture of clay and coarsely powdered mussel shells. This image, on the other hand, is an exact presentment of a certain type, and does not contain in the interior fragments of shells, but in addition to the other points of superiority, has the exterior surface covered with a well defined coat of grayish white clay, an art not usual in our ancient potters.

All these facts seem to show that this image was the work of an artist with more than self acquired skill, and was the result of generations of men combining their experience from teacher to pupil, from master to learner, and was borrowed fron some older center life, and this knowledge of the facial expression, it is suggested, could only be borrowed from Japan or China. The recent emigration by a fleet of canoes of Asiatic Esquimaux by Behring's Straits to Alaska on this continent, fully sustains this suggestion.

The material of the image was submitted to Chemical Assistant Hurty for qualitative analysis, and it was found to contain silicates of alumina, soda and potassium, and sand, humus and oxide of iron. If it was of modern make, it would not have contained part of these ingredients, and if imported from Asia, would have contained the common kaolin of Eastern Asia. But the analysis shows that the image was made up from common swamp clay, and still contained humus or organic matter, and the coating was from the fire-clay of some adjacent coal bank, clearly indicating that it was made of *local materials*, and therefore of *local manufacture.*

The copper axe (Fig. D) is of the usual form and size discovered in the mounds. On analysis, it was found to be composed of copper, with traces of iron and carbon, but without alloy of phosphorus or tin. The analysis shows its origin from the copper mines of Lake Superior, and indicates their line of immigration by these mines to Indiana.

The other articles mentioned were the household implements common about the kitchen fires of this race.

If the examination of this mound and its remains shall serve to throw one ray of light upon the origin of the Mound Builders, even feebly "help to bridge the centuries and tell the wondrous story" of a people lost in silence, the highest wish of the writer will have been accomplished.

GEOLOGY OF PUTNAM COUNTY.

Putnam county is situated directly west of the capital of the State, and Greencastle, the county seat, is forty miles distant from Indianapolis. It was organized in 1821, contains 486 square miles or 311,040 acres, and is bounded north by Montgomery, east by Hendricks and Morgan, south by Owen and Clay, and west by Clay and Parke.

Raccoon creek drains the northwestern parts, passing into Parke at Portland Mills; the northeastern central areas are drained by Walnut creek and its tributaries, flowing into Clay at the extreme southwestern corner. Mill and Deer creeks discharge the water-shed of the south and southeastern areas. These streams furnish ample drainage, a well distributed supply of water, and some excellent mill-sites; there are many other smaller streams and brooks of good water.

The surface in the north and eastern parts is level or gently undulating, and is inclined to be wet in rainy seasons. In the center and southwest it is agreeably rolling, and in the vicinity of the streams, and conglomerate sand rocks, hilly. The soil is a rich calcareous loam or clay, well adapted to grain and grass, and nearly all susceptible of profitable cultivation. The original timber was a magnificent growth of sugar, beech, walnut, ash, oak, and poplar.

The Terre Haute and Indianapolis, and the Indianapolis and St. Louis railways cross the center of the county east and west, and the Louisville and Chicago from south to north, all making Greencastle a meeting point. The Indianapolis, Decatur and Springfield railway traverses the extreme northern tier of sections; united they afford excellent facilities for transportation. The principal towns are Greencastle, Fillmore, Bainbridge, Roachdale, Russellville, Reelsville, Putnamville, and Cloverdale, all showing thrifty life, with well appointed churches, school-houses, stores, shops and residences.

The various geological features brought together from widely separated outcrops and exposures give the following:

CONNECTED SECTION.

QUATERNARY AGE.

	Feet.		Feet.
Alluvium	00	to	30
Loess, or lacustral deposit	00	to	110
Bowlder drift	10	to	100

CARBONIFEROUS AGE.

Coal Measure Period.

	Feet.		Feet.
Conglomerate sand rock	00	to	40
Coal A	00	to	2
Fire clay	00	to	3
Conglomerate sandstone	10	to	30

SUB-CARBONIFEROUS PERIOD.

Chester Group.

	Feet.		Feet.
Kaskaskia limestone	00	to	12
Chester sandstone	90	to	10

St. Louis Group.

	Feet.		Feet.
Concretionary limestone and shale	80	to	100
Gray, flinty, magnesian limestone	30	to	10
Argillaceous laminated deposit	5	to	18

Keokuk Group.

	Feet.		Feet.
Keokuk limestone and shales	50	to	78

Knob Stone Group.

	Feet.		Feet.
Knob shales and sandstone	20	to	50
Knob shales and sandstone, in bores			350
Grand total			885

GENERAL GEOLOGY.

QUATERNARY AGE.

The surface of the county is agreeably diversified, combining in a high degree the useful and agreeable, as rocky scenery, with romantic views of plain and woodland, rich in interest to the economist, all uniting to tell a long story, recorded on rock and plain, of the earth's past, laden with promises of the future.

Soils and surface deposits are formed by the disintegration and destruction of rocks. If derived from local rocks, or a single bed, they are generally thin or obdurate, and the character of the productions—even of a people—

may be declared from their geological deposits. On the other hand, a region having a soil derived from the greatest number of strata is, as a rule, productive and desirable. The soils of Putnam county, although principally composed of the local rocks which give character to the different parts, are also enriched by materials imported from all the paleozoic strata, and thoroughly crushed, mingled and incorporated by the mighty forces of the glacial age; the soil, therefore, is superior, or equal to the best.

ALLUVIUM.

The alluvial deposits or creek and river bottoms which belt the water courses are due to causes now in action. This material is derived from the adjoining banks, enriched by the wear of rolling pebbles and grinding sand, and is cast out by overflows upon the flood plains of the streams. Rich in mineral plant food, it always contains a large amount of soluble organic matter, constituting a valuable and productive farm or garden land. Each bottom field is a gold mine, for its productions will bring gold or its equivalent with less labor than other ordinary pursuits or mines.

LOESS OR LACUSTRAL DEPOSITS.

These deposits are characteristic of an epoch which occurred subsequent to the glacial. The arctic coldness had subsided. A great body or sea of fresh water covered most of the southern half of the State with gulfs, bays and lagoon arms which reached north in the line of the ice thrusts. A warm, almost tropical climate prevailed, giving life and sustenance to the monster animals now extinct, including the American elephant, whose remains have been found at several stations in the county. This deposit, an almost impalpable sand and clay, was slowly formed at the bottom of a quiet waveless lake, filling up the lowest inequalities in the surface, for the lake water did not cover the high lands. Good examples are seen in the level plain adjoining Mill creek, in the southeast parts and in the railway cuts at and west of Oakalla station. Loess loams produce sweet fruits, and being free from pebbles are well suited for the manufacture of bricks. Those for the new State House are being made from this material in Morgan county.

BOWLDER DRIFT.

To the strange phenomena of the glacial epoch we are indebted largely for results which make this soil and surface configuration so desirable—a more than "New Kentucky." A grand river of ice, with its sources among the snowy heights of distant mountains, laden with materials which border the St. Lawrence and lakes Ontario and Erie, pushed its ice foot beyond the western shore of Lake Erie and sent volumes of water through deep cut sluiceways across the State in direction from N. 80 E. to the opposite course west, bringing with it as indications of its origin nuggets of Champlain iron ore and "biscuit stones" of Medina sandstone, etc. Evidences of this violent water flow are seen in the recently opened ancient bed of Lye creek in Montgomery county; in the bores, discovering a cut about fifty feet below the present water level in Six Mile Creek, Owen county; and in the ancient bed, one hundred and nine feet below the present channel of Eel river, in Clay county. In this county the same developments are met in sinking wells near Quincy, just beyond the southern boundary. At the fork of Croy's creek, four miles west of Reelsville, Mr. A. O. Hough put down a bore for coal about 1865, finding the bottom rock one hundred and twenty feet below the present water bed. It seems possible that the ancient Walnut creek flowed S. 80° W. or nearly west by Otter creek, from Oakalla, to the Wabash in a channel now deeply hid but which future developments may discover.

From causes now unknown the source of the ice river was afterwards changed to the northern center of the continent. This glacier moved south in two divisions, one excavating the basins of Lake Michigan, and the other of Huron and St. Clair, the first crossing the State from north, to south 8° to 10° east. The latter was very nearly due south. Combined they are wider than the State of Indiana from east to west and at a point of obstruction in Brown county the ice was about 400 feet deep. It bore upon its surface and in its icy bosom immense quantities of angular rocks, bowlders, gravel, sand and earth from northern regions, which crushed and powdered were mingled with the debris of local rocks planed away and ground up in the mill of nature. The result was that irregularities were cut down, ancient river channels and sluice ways of great depth were filled up and the underlying rocks covered with a gray compact bed of clay, sand, gravel and rocks, termed the bowlder or glacial drift.

Interesting specimens of glacial grooves, striæ and planishing are seen in "Rock Cut," north of Maple Grove station, on the Louisville, New Albany and Chicago railroad, and on W. B. Williams' farm, section 28, township 13, range 4, two miles south of Putnamville. At the first locality the glacier, in its southward movement, filled the valley of the adjoining stream to the east, and was heaped against and ground down the sloping sides and banks of the valley. The planished surfaces, grooves and striæ are distinct and perfect as of yesterday. At the second locality (Williams' farm), the ice flowing from the north was obstructed by a high hill of conglomerate sand rock, against which it steadily advanced with resistless force until it mounted the hill, leaving many planished surfaces, with scars and well-preserved grooves on the summit.

I am informed by Dr. R. T. Brown, geologist, that when the railways of this county were first constructed, at several localities traces of the glaciers' path were laid bare. At some points, where it crossed narrow east-west crevices, etc., he noticed that while the north wall was fresh and natural, the southern wall was scarred and worn by the pressure, indicating not only motion from north to south, but also a deflection of the ice sheet. Other interesting evidences of the glacial flow are noted in the adjoining counties of Owen, Clay and Montgomery, in Indiana Geological Reports, 1875.

Dr. Brown has kindly furnished the following observations, made nearly thirty years ago, of glacial action on the rocks of Putnam and Owen counties:

Professor Collett:

DEAR SIR: In response to your inquiry in regard to my early observations on the traces of glacial action in Indiana, allow me to say that between 1840 and 1850, I made a special study of the "drift formations" in Indiana, and now submit a few notes from memory.

Along the Walnut fork of Eel river, above Greencastle, on the southeast side, the limestone rocks, which in many places are exposed, were ground off and all the exposed angles are rounded. At a point a little southwest from the court house in Greencastle, I observed a considerable surface of rock that was denuded, on which were several well marked furrows with a direction a little west of south. These were repeated even more distinctly on an exposed summit about one-fourth of a mile southwest of Asbury University. The same phenomena were observed in the sandstone crowning the hill south of Greencastle, now occupied by the city cemetery.

On the south side of Eel river, about four miles below Bowling Green,[*] a high bluff of carboniferous sandstone has its surface laid bare for some distance, where the deep grooves and furrows of the Glacial period are preserved with wonderful fidelity. These phenomena in that vicinity have been studied with much care by James Ferguson, Esq., of Ashboro, Clay county, who may be consulted on the subject.

Going south from Greencastle, I observed in the limestone hills facing to the north the rocks laid bare and their angles ground off, while the hills facing south were either covered with a deep deposit of drift material, or if the rocks were exposed the angles presevd their original sharpness. This continues to the vicinity of Bloomington, below which it is not so well marked.

Respectfully,

R. T. BROWN.

PALEOZOIC GEOLOGY.

CARBONIFEROUS AGE.

COAL MEASURE PERIOD.

The coal measures are the most recent rocks exposed, and comprise the southwestern portion of the county. Beginning at Portland Mills, they generally form the surface rock west of Little and Big Walnut Creeks; south of Reelsville, they broaden to the east to near Cloverdale, and thence southwest by Doe Creek to the southern boundary.

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[*] Owen county.

These rocks are almost wholly, well laminated or massive beds of conglomerate sandstone, carrying, as usual, the thin coal seam A, and pockets of clay and kidney iron ore. Outliers of conglomerate exist east of this line, as drawn on the map, as at Cemetery Hill, south, and the highlands west of Greencastle, while sub-carboniferous limestones are also exposed in deeply eroded valleys to the west. And this feature of outliers and exposures occur east and west of each of the several geological lines, which are intended to be merely approximations.

The conglomerate sandstone is exposed in well-developed ledges, forming the surface rocks, and the steep bold bluffs of the valleys. It is a coarse, red, or yellow ferruginous sandstone, excellent for walls, foundations and other hammered masonry, but the abundance of superior limestone overshadows its ordinary good fire and weather-proof qualities.

A single outcrop of coal near the top of one of the highest eminences in the county, on Aaron Bales' land, section thirty-four, town thirteen, range four, was possibly referable to seam B. An adit had been driven under the hill two hundred or three hundred feet long. The mine was not in work, and measurements could not be made. The coal was reported three feet at the thickest pocket, with an average of less than two feet. The product was said to be inferior and was used for grates. There is no probability of finding coal B in this district, sufficiently developed to pay for working.

The aluminous shales near the base of the conglomerate are a pretty constant feature, and generally occupy the place of coal A. Where the latter is disseminated, thick beds of black, slaty shale are found at that horizon, and sometimes pockets of kidney iron ore, and bands of pyrites.

The conglomerate coal A, occurs at intervals all over the district. At a few stations it attains a thickness, in small pockets, of two or three feet, but such pockets, or pools, are limited in width to a few yards, or rods. As a rule the seam is barren or only one or two inches thick, and will not exceed an average of four inches. The product is at the same time sulphurous and inferior. Money spent in mining at this horizon will not earn an average return of ten cents on the dollar.

At Cemetery Hill, a mile south of Greencastle, is a coal measure outlier, with the following exposure:

Section at Cemetery Hill.

	Feet.	Inches.
Conglomerate, with *Lepidodendra* and *Stigmaria*.........	20	00
Laminated sandstone...	8	00
Thin coal..	00	06

	Feet.	Inches.
Shaly sandstone	12	00
Pyritous shale, with iron nodules	8	00
Black slate and coal A, (?)	3	00
Shales and sandstone, with coal plants and large pronged fucoides	31	00
Limestone in brook	10	00
	92	06

On the Black farm, section 22, township 14, range 5, the high hills exhibited massive ledges of conglomerate, with good grit stones:

Section on Black's Farm.

	Feet.	Inches.
Ferruginous sandstone, with "pipe" and "pot" iron ore.	10	00
Heavy sand rock, with false bedding	15	00
Massive conglomerate	35	00
Pyritous shale, with "rock houses"	5	00
Black slate	2	00
Coal A	1	00
Fire clay	2	00
Chester and St. Louis limestone to Walnut Creek, partly covered	95	00
	165	00

In the vicinity of Morton, a depression in the underlying rocks gives an eastern extension of the coal measure rocks, and many beautifully preserved "ferns" and trunks of plants indicate the horizon of coal A., the superimposed sand rock having been chiefly eroded.

At Portland Mills the conglomerate is well exposed. A wall, boldly escarped, guards the north bank of Raccoon Creek. The massive layers offer in abundance good fire and weather-proof building material and good grit stones. Romantic valleys are deeply cut into or gash the sides of this deposit. The surroundings are grand and full of wild beauty. By a strange freak of nature, indicating erosive currents at the beginning of the coal measures, and the destruction of some of the intervening rocks, the conglomerate rests at the mill directly upon the St. Louis limestone, but less than a mile north, on the Gregg farm, the opposite sides of a valley exhibit conglomerate and St. Louis rocks, showing grave inequalities in the bottom of the ancient sea, or, as is more probable, that not only the Chester rocks were entirely removed, but also that the St. Louis rocks had been eroded to an extent not less than 100 to 150 feet at the beginning of the coal age, by the strong currents which transported and deposited the coarse materials of the conglomerate. Many well planished and striated bowlders of granite indicate the glacial origin of Raccoon valley. Some, imported by the ice flow from the region north of lakes Huron and Superior, were still two to four feet in diameter.

Section at Portland Mills.

	Feet.	Inches.
Slope—loam	10	00
Conglomerate sandstone—massive	80	00
St. Louis limestone, with *Athyris ambigua*, *Syringopora*, etc.	4	00
	94	00

The hills in the vicinity of Reelsville, are capped with conglomerate, exposing sub-carboniferous limestone and shales in the creek valleys.

Section at Reelsville.

	Feet.	Inches.
Slope, drift clay and loam	90	00
Bowlder clay	12	00
Coal A	1	00
Fire clay	4	00
Ferruginous conglomerate sand rock	76	00
Chester limestone, Kaskaskia division	38	00
St. Louis limestone to creek	26	00
Total	247	00

The following section on the roadway leading south from the village is given to show how variable are the strata and qualities of the rocks, and the differences that were observed in localities scarce half a mile apart:

Section South of Reelsville.

	Feet.	Inches.
Slope, drift clay	30	00
Conglomerate sandstone	40	00
Buff and gray shale with plates of sandstone	6	00
Ferruginous limestone	2	6
Black pyritous shale	11	00
Chester limestone, Kaskaskia division	48	00
St. Louis limestone to creek at road bridge	12	00
Total	149	6

During the petroleum excitement (about 1865), a prospecting bore was put down in the east side of the village, commencing eighteen feet above low water in Big Walnut Creek. Wm. Reel, Esq., one of the managers of the enterprise, gave from memory the following statement of strata developed:

Section in Reelsville Artesian Well.

	Feet.	Inches.
Drive pipe, in sand, gravel, etc	45	00
St. Louis and Keokuk limestone	250	00
Blue knob shale—brine	625	00
Sandstone	25	00
Devonian black slate	65	00
Devonian hard limestone	40	00
Argillaceous silurian limestone—brine	150	00
Cavity ?	6	00
Hard cherty limestone with cavities, the flow of white sulphur water casting up the boring debris	34	00
	1,240	00

There resulted a strong flow of white sulphur water highly charged with sulphuretted hydrogen gas, and containing chlorides of sodium, calcium and magnesium, sulphites of the same bases with traces of bromine and iodine, etc. It had a pleasant saline, sulphurous taste and pungent odor, and was found to have great medicinal efficacy in cases of dyspepsia, rheumatism and ague. It was considered a specific in diseases of the liver and kidneys, and although the outlet was covered by the flood of 1876 its "magic cures" are still held in kind remembrance in this vicinity.

Other outcrops of coal seam A occur north and northwest of Reelsville; generally thin and unworked. The following exposures were noticed of

Coal Seams South of Reelsville.

	Feet.	Inches.
Southwest quarter Section 26, T. 13 R. 4, A	1	00
Northwest quarter Section 34, T. 13 R. 4, A	2	00
Northwest quarter Section 28, T. 13 R. 4, A	2	00
Northeast quarter Section 28, T. 13 R. 4, A (shaft)	2	00
Southwest quarter Section 7, T. 12 R. 4, A	-	—
Northeast quarter Section 3, T. 12 R. 4, A	1	06
Northwest quarter Section 18, T. 13 R. 4, A	1	06
Southwest quarter Section 22, T. 13 R. 4, A (in well)	1	00
Northeast quarter Section 27, T. 13 R. 4, A (in well)	0	06

These coals are only opened for local use now, and will not pay to work except by stripping; but, in the distant future, when coal may possibly become scarce or railway transportation exhorbitant, seams eighteen inches thick and even less, will be worked, as such seams are now sometimes worked in Europe.

The whole district is bountifully supplied with sandstone; at many localities, in massive ledges of excellent quality for foundation and hammered masonry, it is fire and weather proof. At other points good grit stones are reported.

Six miles southwest of Cloverdale on the northeast quarter of section 12, town 12, range 5, is a very considerable outcrop, of rich band and kidney iron ore, in a wild, deep ravine. It was mined in 1860 by the proprietor, and some thirty tons sold to the Knightsville furnace. It was found to be an excellent ore to mix as a flux with the Missouri or Lake Superior ore. But the expense of mining and hauling was fully equal to the market value, and the enterprise was abandoned.

Superior potter's clay was noticed near the school house, northwest quarter section 17, township 12, range 4, which is worthy the attention of potters and tile makers. In a deep ravine, northeast quarter, section 8, township 12, range 4, is a bed of silicious shale, filled with eccentric and comical concretions of almost every imaginable shape, as if trial efforts of the "plastic hand of nature."

At many localities throughout this portion of the coal measures casts of *Lepidodendron*, *Sigillaria*, *Stigmaria* and *Calamites* were seen, with occasional fronds of ferns and leaves of *Cordaites*, in a fragmentary condition indicating the violent ocean currents which traversed the old shore line and deposited the coarse, sandy conglomerate.

The soil of this district, derived largely from the destruction of local sandstones and shales, is sandy, producing moderate crops of grass, rye, wheat, corn, etc. The hill tops successfully and profitably produce the best of fruits, as apples, peaches, pears, etc.

SUB-CARBONIFEROUS PERIOD.

CHESTER GROUP.

No workable coal exists below this horizon in Indiana, so that when the rocks in place show that they belong to this or a lower horizon, time or money spent in search of coal is worse than wasted. The Chester beds occur immediately under the coal measure conglomerate, and occupy as surface rock a narrow belt along its eastern outcrop, and also surrounds the base of such outliers as those south and west of Greencastle.

The Kaskaskia limestone, or upper division of the Chester, varies from nothing to twenty feet in thickness, and is usually persistent in the southeastern parts, and always contains characteristic fossils. The Chester sandstone is often only locally present. It is generally soft and well laminated, and contains coal measure plant remains. It varies from naught to seventy feet in thickness, being pretty well developed about Cloverdale, and thence south.

The Chester rocks thin out, or were eroded before the deposit of coal measure strata in the northern part of the county. In the vicinity of Reelsvile the following fossils were noticed, mentioned in the order of their discovery:

Productus cora, P. semi-reticulatus, Athyris ambigua, A. sub-lamellosa, Streptorhynchus crenistriatus, Zaphrentis spinulifera, Dichocrinus spinifera, Pentremites pyriformis, P. godoni, Agassizocrinus pentagonus, etc.

Soils derived from Chester rocks are silicious clays, but where the Kaskaskia limestones are well developed, are often reddened by iron set free by destruction of that stratum and they are generally fertile.

ST. LOUIS GROUP.

The St. Louis beds form the surface rocks in a well marked division from four to eight miles broad, extending from the extreme northwstern to the southeastern corners of the county, with denuded extensions in the valleys of the Chester and coal measure beds. These strata are known as the "cavernous" or "concretionary" limestones of the Western States and are remarkable in the southern parts of this State for caverns, sunken valleys and subterranean rivers. South and east of Greencastle many funnel shaped sink holes, which receive and deliver the rainfall to hidden streams, indicate the probability of small caverns yet to be discovered here. The limestones vary much in quality. Some are nearly pure carbonate; others are silicious or aluminous, and beds of shale, clay and argillite are interpolated.

The connected section gives a condensed statement of these beds, but as they vary stratigraphically in very short distances, so that a section taken at any one locality can not be duplicated at another, local sections are given, and it is necessary in determining geological horizons that fossils be depended upon to identify such beds.

Before the deposits of the superimposed Chester strata, the St. Louis beds presented a wonderful succession of hills, domes, ridges and valleys. Part of these were the result of the process of deposition, as at a dome-shaped irregularity on the northeast quarter of section 3, township 12, range 4, where the St. Louis limestone dips east as well as west; and on the northwest quarter of the same section a partly uncovered ridge is seen extending north, south against the sides of which the Chester sandstone is deposited with such angular false bedding as would compensate for and rectify the irregularities of the surface, at one point the overlying strata pitching at an angle of 40°.

Coverdale lies in the western edge of the wide valley path of the north-outh glacial flow, that removed from this area the coal measure and Chester rocks which tower so grandly a few miles to the west, and passing south excavated the chasm now filled with lacustral silt along Eel river, so easily observed in the vicinity of Quincy. Sandstones and outcrops of coal A are well seen along the western bluff of this valley. On the Sackett farm two miles southwest of the village, stone has been quarried and the following strata exposed:

Section at Sackett's Quarry.

	Feet.	Inches.
White St. Louis limestone	6	00
Laminated limestone, filled with chert nodules, like sponges	9	00
Gray *Lithostrotion* bed	5	00
Creamy yellow stone	2	00
	22	00

The following fossils were noticed: *Spirifer keokuk, S. leidii, Productus cora, P. semi-reticulatus, Rhynchonella sub-cuneata, Zaphreutis spinulifera, Lithostrotion, proliferum, L. mamillare,* spines and plates of *Archeocidaris,* and plates of *Oligoporus. L. proliferum* was plastered over large blocks of stone, generally solitary, but sometimes in charastic clusters.

From the top of Gilman's hill, northeast quarter, section 1, town 12, range 4, a view is enjoyed of the peaks and elevations beyond Cataract, probably Spangler's hill, looming up against the southern sky, blue in the six miles of distance. The horizon slopes from the central pinnacle at Cataract west to Eel river valley and east towards Gosport and White river, indicating an anticlinal or dome of elevation.

About a mile east of Cloverdale, on descending from the limestone hills, a level, flat clay district is found, which extends east beyond Eel river and northeast towards Monrovia, in Morgan county. This area has been deeply eroded during the glacial epoch, removing more than fifty feet of St. Louis limestone, and along the eastern side of the county exposing rocks of the Keokuk and Knobstone groups. The excavation is now refilled with lacustral and fluviatile drift, indicating an abandoned river bed, which once connected by Indian creek with White river valley. The greatest depth pierced in this valley in digging wells discovers beds of dark quicksand, with some pockets of peaty muck in the lowest wells east of Higgins' creek.

Putnamville is located on the National Road, and before the construction of railways was one of the most important towns of the county. Residences, of some of the pioneers of the county and historic citizens of the

State are pointed to with pride, now marked with age. It is famous for valuable quarries of paving, curb and step stones.

James Lee & Sons work their quarry one mile west of town, shipping large amounts of flags, bridge, dimension and rubble-stone. The product has been in use, severely exposed to the extreme vicissitudes of our variable climate, including changes of 60° of temperature in a single day, for over forty years. It has shown capacity to resist the action of frost, fire and ice. Samples, taken, as a rule, from the exposed parts of the quarry when first opened in 1838–40, may be seen in piers, etc., of the bridges and culverts on the National road and in the locks of the canal, the steps of the mother and branch Banks of State, at Indianapolis, and also the steps of the Terre Haute House at Terre Haute, and of the old University building at Greencastle.

As pavement, step stones, and for curbs it is unrivaled. In the last two cases, in the wear of nearly half a century of almost constant use, the loss and breakage will not exceed one-quarter of an inch, or at the rate of half an inch in one hundred years. It is excellent for paving flags. The stone, from natural lamination, may be obtained smoothly dressed and ready for use, except jointing, in slabs three, four, five, six and seven inches thick, of any length and breadth suitable for transportation. Its quality of hardness renders this material desirable for piers and rip-raps exposed to the action of ice and waves. Samples used as back walls and hearths for fire places, and fire boxes of steam engines, have rendered good service.

The stone is a close-grained, hard, silicious limestone, weighs 166.36 pounds per cubic foot, with the small ratio of absorption of 1 to 170; the crushing strength as tested by General Gilmore, U. S. A., is 11,750 pounds to the square inch. It was chemically examined by Professor Cox for the State House Commissioners, with the following result:

Analysis of Putnamville Stone.

	Per cent.
Water dried at 212°	0.30
Insoluble silicates	27.50
Ferric oxide	2.00
Alumina	1.70
Lime	35.23
Magnesia	0.33
Carbonic acid	28.03
Sulphuric acid	2.60
Chloride of alkalies	0.75
Loss and undetermined	1.56
	100.00

The small amount of water absorbed by this stone fully explains why it presents so many good qualities.

Section at Lee's Quarry.

(Putnamville.)

	Feet.	Inches.
Stripping, clay and stone	2 to 10	00
Flagstones, even bedded	00	05
Flagstones, even bedded	00	03
Flagstones, even bedded	00	08
Flagstones, even bedded	00	08
Flagstones, even bedded	00	06
Flagstones, even bedded	00	08
Dimension stratum	2	00
Conglomeratic limestone	00	04
Dimension layer	3	07
Dimension layer	1	09
Diagonal rubble	1	00
Flagstone, choice	00	06
Dimension stone	4	00
Total	26	04

This stone is reported as being exposed on two hundred acres of neighboring land, and nearly similar quarries were formerly worked two miles south of this locality, and a quarter to half a mile east. The stone can be worked winter as well as summer, giving constant employment to operatives as it does not require seasoning. The partings between the upper flags are marked with tracks of crustaceans and other animals, undetermined, and generally present a double row of foot-prints in pairs. Some of the ancient ripple marks are beautifully preserved, telling the story of their aqueous origin.

The adjoining hill is capped with an overlying white limestone, suitable for calcining, which contains St. Louis fossils as *Athyris, Productus, Orthoceras, Pleurotomaria,* crinoid stems, etc.

This stone invites the attention of builders, engineers and street commissioners, where permanence rather than cheap show is desired.

Greencastle, the county seat, is situated on the high, rolling table land, one mile east of Walnut Fork of Eel river. Before the completion of railways, Prof. Tefft insisted it was such a central point as would attract lines of commerce; proving the truth of his statement by declaring, "that from his standpoint the circling horizon fixed it as the central station of the world." The almost wild jest of 1848 is partly realized. Two east and west trunk lines and one from north to south cross at or near the city, while another direct east and west line crosses the northern portion of the county, and gravel roads radiate to almost every part.

It is the seat of Indiana Asbury University, which struggled through pioneer life, aided by the unconquerable energy of the early "circuit rider" with the enthusiasm of his young manhood. It has pursued its steady course, bravely joining in the struggle for education with friendly competitors, yet from lukewarm friends occupying till a very recent date such an old and poor edifice, that when asked for her jewels she could only point to her sons in every proud rank of active life, and claim their achievements as the *alma mater's* crown. Since the late fire the University is supplied with beautiful and well-appointed buildings, and the library, apparatus and museum are fast approaching the excellent condition her generous sons and daughters plan and intend to insure. Her sons have distinguished themselves on every field of peace and war, and have reflected credit upon the university.

Several thriving manufactories are located here, the principal of which is the "Greencastle Nail Works," an extensive and well managed establishment.

Geologically, Greencastle rests upon the upper ledges of the St. Louis limestone. As already mentioned, the conglomerate sand rock of the coal measures caps the summit of Cemetery Hill just south, as also the hills across Walnut, just west of the city.

Stone is quarried for foundations and rock-faced building in the suburbs, including part of the following strata:

Greencastle Section.

	Feet.	Inches.
Cherty limestone, St. Louis	2 to 8	00
Blueish gray limestone, St. Louis	6	00
Dimension stone	3	00
Coping stone	0	10
Coping stone	0	08
Curb stone	0	05
Dimension stone	2	02
Dimension stone	2	00
Dimension stone	1	06
Dimension stone	3	06
	28	01

Similar quarries are found at several points about town, affording an abundant and cheap supply of stone, which meets with the approval of the architects and builders of the city.

An interesting fossil locality was visited in Lockridge's blue-grass pasture, east half of the west half of section 17, township 14, range 4, one mile northwest of town.

Section at Lockridge's Fossil Quarry.

	Feet.	Inches.
Fluviatile drift	10	00
Gray massive St. Louis limestone	12	00
Gray St. Louis limestone with *Orthoceras winchelli, Nautilus coxanus, N. decoratus, Bellerophon hiulcus, Goniatites,* ined, *Dentalium primarium,* etc	10	00
Brown limestone	8	00
Warsaw division	4	00
Covered, to Walnut	15	00
	59	00

Of the above fossils the *Goniatites* were rare, and only imperfect specimens could be secured, as was also the case with *Nautilus decoratus. Nautilus coxanus* and *Dentalium* were common, but the *Orthocerata* could only be estimated by millions to the acre; collectively indicating that not only species but allied genera of these animals, as to-day, were gathered together, and either for mutual defense, favorite food or favorable conditions they assembled in communities on the bottom of the sub-carboniferous ocean. This was the home of a race, for old and young, large and small individuals were found fixed in their stony matrix. It was interesting to notice the *Goniatites,* which began in the Devonian age, flourishing here amid his congeners, to survive the coal measure epoch, and culminate in later rocks, in his possible descendant the *Ammonite.*

On the Drew farm, northwest quarter of southeast quarter of section 16, township 14, range 4, a mile and a quarter north of town, an exposure was examined of the Warsaw division of the St. Louis limestone, only about six feet thick, but rich in the fossils so abundant at Spurgeon's Hill, in Washington county. The following are mentioned in the order in which they were found: *Pentremites conoideus, P. koninckianus, P. varsouviensis, Batocrinus icosidactylus, Platycrinus saffordi, Zaphreutis spinulifera, Syringopora ramulosus, Fistulopora, Sp.(?), Archimedes oweni, Rotalia baylii, Productus punctatus, Athyris hirsuta, A. trinuclea, A. quadrata, Terebratula formosa, T. turgida, T. bovidens, T. hastata, Rhynchonella mutata, R. grosvenori, R. sub-cuneata, R. ricinula, Orthis dubia, Spirifer rostellatus, Eumetria verneuillianum, Myalina Sp. (?), Allorisma Sp. (?), Conocardium cuneatum, Streptorhyncus crenistriatus, Cythere carbonaria, Euomphalus spurgenensis, E. planospira, Nautilus Sp. (?), Dentalium primarium, Pleurotomaria,* 3 *Sp., Murchisonia,* 2 *Sp., Bellerophon sublævis, Phillipsia Sp. (?).*

At the junction or crossing of the T. H. & I. with the L., N. & C. Railways, two miles southwest of Greencastle, the T. H. & I. R. R. works a good quarry for the structures on that road. An extensive opening has been made with every requisite fixture. The following exposure is seen:

Section at Railroad Quarry.

	Feet.	Inches.
Clay covering 3 to	6	00
St. Louis cherty limestone 6 to	3	00
Bluish gray limestone	6	00
Dimension limestone	1	08
Dimension limestone	2	04
Building limestone		08
Building limestone		10
Dimension limestone	2	02
Dimension limestone	2	00
Dimension limestone	1	00
Dimension limestone	2	06
Hydraulic limestone	1	06
	29	08

It will be seen that this stone is deposited in layers with perfect natural partings, suited to the probable demands of builders of the structures usual upon first-class railways. The product is well adapted to the purpose for which it is used.

In this quarry many well preserved and interesting fossils characteristic of the St. Louis group are found, including *Syringopora ramulosus, S. multattenuata, Zaphrentis spinulifera, Spirifer keokuk, S. rostellatus, S. setigerus, S. lateralis, Productus cora, P. punctatus, P. ovatus, P. semi-recticulatus, Athyris trinuclea, A. lammaellosa, A. hirsuta, Allorisma regularis, A. sinuata, Terebratula bovidens, Bellerophon hiulcus, Nautilus coxanus, Orthoceras winchelli, O. Sp. ?* and many shark's teeth. In the overlying loose deposit were noticed *Lithostrotion mammillare,* and *L. proliferum.*

On the adjoining part of northeast quarter, section 32, township 14, range 4, belonging to the heirs of William Steeg, an extensive bed similar in stratification and fossil remains is worked for lime by H. C. Steeg, manager, employing a "perpetual burner" 32 feet high and 9 feet in diameter. The kiln contains 1,050 bushels and the calcined stone is drawn twice a day, giving a daily yield of 300 bushels. The capacity of the fixtures is for 90,000 bushels of lime per annum, but the maximum output has been 45,000 bushels for a single year. The lime sells for 12½ cents per bushel of 70 pounds, delivered on the cars. He also furnishes dimension stone.

The proprietor states that the soil of the Steeg farm was badly exhausted at the time of his purchase, but now enriched with refuse lime, gives fair returns, making a profit of 100 to 400 per cent. on the cost of lime applied. He uses 100 bushels per acre of old slacked lime, or 30 to 40 bushels of the same freshly burned, and has used it on all the crops grown on the home farm of 120 acres with marked benefit. On a worn field sowed to wheat in the fall of 1879, six acres, part of a field was limed and produced 12 bushels to the acre, the balance, not limed, yielded only one and one-half bushels per acre. Sandy clays, as a rule, are most benefitted by an application of lime as manure.

At Oakalla, on the I. & St. L. R. R., five miles west of Greencastle, extensive beds have been opened, exposing strata admirably suited in thickness for dimension and rubble stone, for foundations, piers, etc. Where great strength is required to withstand the force of currents of water, floating ice, etc., it has been considered by builders and engineers of superior quality. The product has been used for bridge piers, culverts and foundations on the line of the I. & St. L. R. R., and a large demand has arisen from other points.

Eppinghausen & Johnson's quarry is just east of and adjoins the village, where the following strata are seen:

Section at Eppinghausen & Johnson's Quarry.

	Feet.	Inches.
Clay slope	4 to 2	00
St. Louis limestone—laminated	8	00
Heavy bedded limestone	6	00
Buff—heavy limestone—fossils	7	00
Blue—strong limestone	1	04
Blue—building limestone	4	00
Lithographic limestone—angular argillite	3	06
Bridge limestone	3	00
Flinty bed, for rubble and rip-rap work	8	00
Magneso-argillaceous bed, filled with *Lithostrotion proliferum*, and plates and spines of *Archeocidaris norwoodi* to Walnut Creek	18	00
Total	60	10

Messrs. Eppinhausen & Johnson employ a "perpetual burner" kiln, 30 feet high, with an inside diameter of 8 feet, built of stone, which holds 700 bushels, giving a yield of 250 to 300 bushels of lime per day. Deducting for warm weather and accidents, the annual product is from 40,000 to 50,000 bushels. Their maximum sale was 52,000 bushels of lime in 1874. The lime is of the quality termed "hot" or "fiery," and should be slacked and made into mortar two weeks before use, when it works "cool" and will not "pop" or "scale" the surface of plastering. The upper strata makes the coolest lime, and the lower ledges are chosen for masonry, rip-raps and metaling roads.

Torr Brothers have an extensive and well-appointed quarry, adjoining the latter on the east. They ship large amounts of lime, but give special attention to orders for dimension stone for heavy masonry.

Section at Torr Brothers' Quarry.

	Feet.	Inches.
Slope—loam	18	00
Sandstone	14	00
Cherty St. Louis limestone	4	00
Light gray limestone, in layers 4 to 10 inches	6	00
Blue limestone—*Productus*	1	08
Blue limestone, rich in shark's teeth, and spines with *Productus cora*, *P. punctatus*, *Spirifer keokuk*, *Athyris ambigua*	2	02
Lithographic stone	0	04
Blue limestone crowded with *Zaphrentis spinulifera*	0	08
Gray building limestone, with *Orthoceras*, *Spirifera*, *Producta*, *Athyris*, shark's teeth, etc	0	10
Gray dimension stone of superior quality, rich in above fossils	2	04
Dark gray dimension stone, used for piers, with above fossils, and *Allorisma regularis*, and *Ariculopectan indianensis*	2	06
Blue hydraulic limestone	1	06
White building stone without fossils, except flat teeth of sharks	6	00
Banded lithographic argillite	6	00
Heavy lithographic argillite	2	00
Light gray stone for calcining	5	00
Flinty limestone, with shark's teeth, crinoids and bryozoans	7	00
Buff magnesian limestone, *Lithostrction prcliferum*	5	00
Gray shale	2	00
Blue limestone to creek	10	00
Total	97	00

In this quarry all the foregoing strata, from the flinty bed at the top to the coarse stratum near the bottom, are utilized, yielding good lime and well-shaped blocks of dimension and rubble stone. The *Lithostrction* bed is rich in calyces, clustered or solitary. Some of the latter ranged from small, to one foot long by an inch and a half in diameter at the cup.

The following additional fossils not in place were observed in the debris of the quarry: *Productus semi-reticulatus P. punctatus*, *P. ovatus*, *Aviculopecten missouriensis*, *Scaphiocrinus* (*indt*), *Bellerophon hiulcus*, etc.

The face of the quarry presents an interesting exhibit of inequalities in the bottom of the sub-carboniferous ocean. The center is depressed about five feet in a worked face of two hundred feet.

Messrs. Torr calcine by a "perpetual burner" or kiln, twenty-nine feet high, with diameter of eight feet and capacity for 700 bushels of stone. The out-put is 150 to 200 bushels of quick lime per day. Their kiln requires six barrels of coal to burn fourteen barrels, or twenty-eight bushels of stone. Lime sells for 12½ cents per bushel on the cars.

I am informed that there is a large amount, say 30,000 to 40,000 bushels, of slack or waste lime now unused, which could be furnished for the expense of loading. This invites the attention of farmers and owners of the sand prairies and clay loams of Vigo, Putnam and adjoining counties.

Moss & Hillis' quarry, half a mile east of Oakalla, turns out a large amount of lime. They employ a "perpetual" kiln or burner, suited for using coal, 27 feet high, with the oven 9 feet in diameter. The product is 150 to 200 bushels of lime per day, but their fixtures have a maximum capacity of 70,000 bushels per annum. The face of their quarry presents heavy bands of limestone from three to five feet thick, which "caps" and breaks in shapely blocks of dimension stone for piers and rubble masonry. Nearly every strata may be profitably calcined. The upper strata are rich in shark's teeth and spines.

Fern is a small telegraph station or passing switch of the I. & St. L. railroad a short distance west of Oakalla, surrounded by high hills and deep gorge-like valleys, walled with sandrock. It is a favorite pic nic ground. The precipitous rocky walls are covered with a beautiful and interesting variety of ferns, mosses and lichens, which invite and command the attention of the student and lover of the beautiful in nature.

Going north from Greencastle many outcrops and quarries of St. Louis limestone were observed, presenting ledges of rocks so similar to those already given that repetition is unnecessary. The surface outlook is characteristic of this limestone, and is plane on the plateaus or gently undulating, moulded into long rolls and slopes by the action of air and moisture during ages of time. The soil is a calcareous loam and was originally clothed with a stately forest, composed of oak, poplar, ash, walnut sugar, etc., trees which indicate and characterize the soil that produces them. The sharp cuts of the creeks and brooks where rocky exposures are seen, were exceptional scars on the face of nature so recent as to lack the healing and smoothing element of time.

From an elevation high enough to include the whole county from east to west the autumnal foliage would present north-south lines of brilliant colors, strongly marked and of magic splendor. At the time of my visit (Oct., 1880), the usual summer was followed by a warm, dry autumn, ripening the leaves of all the trees to full maturity before touched by frost. The eastern or Knobstone division of the county showed a back ground of the pale green of the beech, on which trembled as stars in the sky a never ending medley of orange, straw, red and other neutral tints of their companions, with occasional clumps of gum, dogwood and maple to give vivacity to the modest scene. In the western or coal measure district, the background was the russet and brown of the oaks, flecked with strong blocks and lines of vivid colors. In the central or St. Louis division, both the other parts merged and mellowed their contrasting colors, uniting to crown every hill and deck every valley with a foliage that has never, can never, be painted or described; in which the scarlet, crimson and orange of the sugar and dogwood contrast in quivering life with gold, pink, green and russet of the elm, beech, oak, hickory, poplar and minor shrubs. It is not the display of a single tree or clump, but the whole woodland, united in a glorious blaze of untiring beauty. Soon the ground too is spread with a carpet of full ripened leaves, which with every breath of air is stirred into an ever-changing kaleidoscope of colors, the whole forming an attraction which would justify a long journey to witness and enjoy.

The forests and their beauty are interesting, but from a practical standpoint the natural growth of blue grass (*poa pratensis*) is more attractive. The soil is perfectly adapted to this grass, pushing it to green luxuriance with the first warmth of spring, to ripen in the plentiful season of summer; it springs to renewed growth with the fall rains and frosts of autumn, to remain green and nutritious during the winter. We can hardly conceive of a plant so universally useful and productive. The intelligent farmers and graziers of Putnam county fully appreciate its unrivaled qualities, and are well satisfied with their comfortable homes, productive farms and independent lives derived from this source.

The grazing farms of Messrs. Stevenson, Lockridge, Farrow, Bridges, Darnall, Fordyce, etc., etc., under the intelligent direction of their proprietors, are not only highly profitable and ornamental to the region, but serve as models that others may copy advantageously.

The St. Louis rocks of this central region furnish good stone for foundations and lime; heavy beds of limestone occur a mile north of Portland Mills, and thence to near Russellville, near the line of the I., D. & S. Railway; good outcrops of stone, which has been calcined, were observed on sections 30 and 31, township 16, range 5.

KEOKUK AND KNOBSTONE GROUPS.

The different strata of these groups form the surface rocks directly east of the St. Louis beds, beginning on a line drawn from near Fordyce's station, on the I., D. & S. railway, thence in general direction southeasterly to the valley of Mill creek, in the township of that name. The soil formed from Keokuk rocks is very similar to that in the St. Louis group, but may often be recognized by a ruddy brown color. The surface underlaid by Knobstone beds is flat and inclined to be wet, and until drained is better adapted to the growth of meadow grasses. When properly drained it produces the cereals well and the best of grasses.

The two groups are considered together for the reason that the total thickness of the Keokuk rocks does not exceed 80 feet, and the greatest single exposure of Knobstone beds was not over 35 feet. Hence from a connected description, a locality may be more easily recognized than if these groups were considered separately.

On the Fordyce farm, southeast quarter section 3, township 16, range 5, in the railway cut, and thence continued to the quarry in the valley, the following exposures were seen:

St. Louis-Keokuk Section.

(Fordyce Farm.)

	Feet.	Inches.
Modified drift......10 to	5	00
Glacial drift......20 to	6	00
St. Louis beds, shale and limestone with *Pentremites conoideus*, *Coscinium Sp.* (?) *Terebratula formosa*, *T. turgida*......	3	00
Keokuk shaly limestone with *Zaphrentis dalii*, *Z. cornucopia*, *Aulopora gigas*, *Oligoporus nobilis*, *Actinocrinus Sp.* (?) *Pentremites woodmani*, *Spirifer keokuk*, *S. neglectus*, *S. pseudolineatus*, *Athyris hirsuta*, *A. sublamellosa*, *Productus cora*, *P. punctatus*......	38	00
Heavy Keokuk limestone in quarry......	2	06
Total......	54	06

At Hicks' Mill, section 14, same town and range, the dam is built upon and against Knobstone beds, which are exposed in the bluff to a height of thirty-five feet, covered with material from the glacial drift, and fragments of Keokuk limestone. The Knobstone layers are shaly, and so pyritous that they are liable to split and disintegrate on exposure to the air.

An extensive quarry has been opened on Mrs. Cashew's land, south west quarter section 6, township 16, range 4, near Raccoon station, and immediately by the side of the railway track. The knob sandstone is here heavily banded, and is colored bluish gray, but soon weathers to buff. The strata dip, west 15°, south 165 feet to the mile. The following was taken:

Knobstone Section.

(Raccoon Station.)

	Feet.	Inches.
Buff Rubble stone	15	00
Heavy band, in layers	6	00
Massive ledge	4	04
Flags, for paving	1	00
Quarry floor	...	08
Total	27	00

This stone is readily split and works well. It was used in the construction of the piers for the railroad bridges over Walnut and Raccoon creeks, and for the coping of the Wabash bridge at Montezuma. The foundation of Brown & Boyd's elevator at Indianapolis, is also from this quarry.

Near the brick chapel on Robert Glover's land, an outcrop of Keokuk limestone was observed. It was crowded with stems of crinoids of species characteristic and peculiar to that group.

In an interesting valley on the Hillis farm, two and a-half miles north northeast of Greencastle, the junction of St. Louis and Keokuk, beds was observed.

Hillis Section.

	Feet.	Inches.
St. Louis limestone,—Warsaw division, with crinoid stems, *Productus punctatus*, *Streptorhynchus crenistriatus*, and shark teeth	5	00
Shaly parting—pyritous	2	00
Argillaceous, St. Louis limestone	14	00
Blue slaty, St. Louis limestone	2	00
Keokuk limestone to brook with *Streptorhynchus crenistriatus*, *Productus cora*, *P. semi-reticulatus*, *Spirifer keokuk*, *S. striatus*, *S. lateralis*, *Orthis dubia*, *Terebratula trinuclea*, *T. hastata*, *Aulopora gigas*, *Zaphrentis dalii*, etc	5	00
Total,	28	00

At the "stone cut" on the Louisville, New Albany and Chicago Railway, near Maple Grove Station, about four miles from Greencastle, is an interesting locality. Many well preserved shark's teeth have been here obtained, and the wonderful record of the glacial forces "graven on the rocks forever" has been already noticed. It also shows the junction of the Keokuk with the underlying Knobstone, beneath the railway bridge, in the bed of the creek; the last visible only at low water.

Keokuk-Knobstone Section.

(Stone Cut near Maple Grove.)

	Feet.	Inches.
Bowlder clay	40	00
Keokuk limestone, planished and striated over fifty feet square, course of striæ from east 80° north	9	00
Shaley clay	2	00
Argillaceous limestone with *Productus, Athyris, Streptorhynchus*	11	00
Heavy brown limestone, with *Ptilodyctia carbonaria, Productus punctatus, P. costatus, P. semi-reticulatus, Streptorhynchus crenistriatus, Spirifer keokuk, S. striatus, S. pseudolineatus, S. Sp? Athyris sub-lamellosa, Terebratula hastata, Aviculopecten indianensis*, etc., etc	25	00
Knobstone shale in creek	2	00
Total	69	00

The foregoing Keokuk-Knobstone section is characteristic, and will, it is believed, enable students or citizens to recognize these formations when elsewhere exposed in the county.

ECONOMIC GEOLOGY.

The soils of the county and their different adaptations have been already considered. This county was settled and brought to cultivation over half a century ago. Good crops have been the rule, and many of the fields are still strong and fertile. This fertility may be perpetually continued by judicious culture of blue grass, or by a rotation of crops which makes clover an element; for clover is a safe and profitable reliance in western agriculture.

Less fertile or worn tracts, which have been robbed of soluble silica by wash of rains or long cultivation, may be quickly restored by the use of lime; most of the soils of this county, although underlaid by the parent stone, are deficient in lime. The abundance of this material, and the ease with which every log heap may be turned into a lime kiln, invites the use of this fertilizer.

EDUCATIONAL.

Asbury University was founded by the pioneer preachers of the Methodist Episcopal Church. It has time and again triumphed over difficulties overwhelming to hearts less brave, and now offers facilities for academic as well as collegiate education to both sexes. It has been a large source of profit to the neighboring farmers and gardeners, but of wider importance, it has been a fountain of intelligence and morality, which has strongly molded the character of the neighboring citizens and directed their efforts for truth and right. The University, sharing in the laurels won by her sons in the forum, the pulpit and at the bar, may confidently expect richer support in the future.

School-houses are seen in every part of the county, and the common schools are almost academies in efficiency.

TIMBER.

The original forests are nearly gone, but large tracts have been preserved, which offer supplies of the best timber for home use and export. Oak, sugar-tree and hickory are most plenty, and of superior quality. Immense quantities of poplar and walnut lumber have been shipped and sold at good prices.

LIVE STOCK.

This department of husbandry is the pride of Putnam county. The citizens bringing with them from Kentucky the skill and experience of their Southern ife—the brilliant memories of Kentucky achievements on field and turf—have fairly rivaled the triumphs of their old home. Good swine, sheep and horses are common, but their stately short-horns are equal to the best, and well repay for intelligent care, adorning every grazing farm with forms of beauty.

MANUFACTURERS.

Manufacturers are not as extensive as they should be. With cheap coal, plenty of timber and stone, home supplies of food, and a healthy, elevated situation, Greencastle and the county offers strong inducements for promoting industrial enterprises. The nail factory, grist, saw and planing mills, woollen factories, etc., are already firmly established; yet additional capital may be profitably invested.

WATER POWER.

Coal is cheap—water power is cheaper. The spring-fed streams offer favorable sites for mills, and factories not requiring heavy power, some of which are not now occupied.

GRAVEL AND STONE FOR ROADS.

Gravel sorted by fluviatile action from the glacial drift is found along the principal streams and creeks in the northern part of the county. This is the best possible material for making wagon roads, and is easily accessible. In other parts limestone is found at short distances. Many good pikes are already constructed. More should be built, for there can be no complete enjoyment of property and the fruits of labor, no just realization of a happy life, without fair commercial and social intercourse.

BUILDING STONE.

The quarries of building stone and their qualities have been already mentioned herein. The supply is without limit. Calls for any amount can be promptly met. Samples of all the different kinds may be seen in the public and private buildings of Greencastle, and the piers under the bridges of the pikes and railways. The sandstone beds have scarcely been opened. This rock could be relied upon for cheap material of great durability.

GLASS AND GRIT STONES.

Glass and grit stones occur at several localities in the Conglomerate. It is sufficiently free from iron to make fair glass. The grits should be utilized for grindstones and other domestic purposes.

BRICK CLAYS.

Clays suitable for brick are so common as scarcely to merit mention, but in the near future an extensive demand will arise. Superior loess clays are found on the I. & St. L. railroad, west of Oakalla, and at other points. Good potter's clay was noticed southwest of Cloverdale.

FRUIT.

Apples, pears and the small fruits are abundant. On all the high plateaus and especially on the elevated sharp ridges in the western parts, the trees are thrifty and bear well. The fruit fully matures and ripens to the brightest colors. The hill-tops west of Eel river offer situations where the effects of sudden cold snaps are mitigated by the surrounding deep valleys, and crops of apples are sure and profitable.

THANKS.

Acknowledgments are made to the citizens of the county for co-operation and assistance. Thanks are due to President Hammond, of the I., D. & S. railroad, for transportation and advice. To Engineer Peck, of the same, for tables of altitudes on that line. To the faculty of Asbury, to Dr. Keightley, Allen Darnell, Hon. A. Daggy, Torr Bros., Hon. W. G. Neff, and others.

TABLE OF ALTITUDES.

MONROE AND PUTNAM COUNTIES, ETC.

The elevation of points on lines of railways which cross Putnam and Monroe counties, are given, with a few extra limital stations for comparison. The table of the Indianapolis, Decatur and Springfield is furnished by Engineer Peck. That of the Louisville, New Albany and Chicago is given by Marshal Morris, Engineer, and George M. Smith, Superintendent. Those on the Terre Haute and Indianapolis and Indianapolis and Richmond Railways are made from instrumental measurements on a profile of those lines and from statements furnished by Joshua Staples, Chief Engineer of Terre Haute and Indianapolis Railroad. They are given for the reason that they include so many points in counties reviewed in this report.

INDIANAPOLIS, DECATUR AND SPRINGFIELD RAILWAY.

	Feet Above Ocean.
Indianpolis Union Depot	721
Track at Eagle creek	745
Track at Mitchell's mill	811
Track at Marion and Hendricks county line	843
Track at Tyrone Station	884
Big White Lick creek	836
Track at White Lick creek	867
Track at Second Principal Meridian	944
Track at Montclair	971
Track at North Salem	900
Eel river bottoms	859
Eel river bridge track	890
Track at Hendricks and Putnam county line	924
Track at Barnard—Fort Red	914
Track at Roachdale crossing	851
Raccoon creek valley	742
Track at Raccoon creek bridge	752
Track at Fordyce Station	868
Track at Russellville Station	859
Track at Putnam and Parke county line	790
Track at South Waveland	801
Track at Guion, crossing of Logansport and Terre Haute Railroad	641
Little Raccoon valley	634
Track at Bethany	760

	Feet Above Ocean.
Track at Marshall	612
Track at Bloomingdale	656
Track at Montezuma	507
Surface of Wabash river at Montezuma	474
Hillsdale, crossing of Evansville, Terre Haute and Chicago Railroad	500
Hood's crossing, one mile east of Dana	662
Track at Dana	656
Track at Indiana and Illinois State line	641
Scotland, Illinois	641
Chrisman, crossing, P. & D. R. R. R., Illinois	661
Track at Cherry Point, Illinois	660
Track at Metcalf, Illinois	675
Track at Hume, Illinois	661
Track at Edgar and Douglas county line, Illinois	664
Track at Newman, Illinois	653
Track at one mile east of Camargo, Illinois	684
Track at Camargo, Illinois	651
Track at Tuscola, crossing, I. C. R. R., Illinois	665
Track at Douglas and Piatt county line, Atwood Station, Illinois	681
Track at Hammond, crossing, C. & P. R. R., Illinois	685
Track at Piatt and Macon county line, Illinois	740
Surface of Sangamon river	602
Decatur, crossing of Wabash and Illinois Central Railways, Illinois	676

TERRE HAUTE AND INDIANAPOLIS RAILROAD.

Track at Indianapolis depot	721
Track at Clayton Summit	906
Track at Fillmore	859
East line of Putnam county	897
Track at Greencastle depot	841
Track at junction with L. N. A. & C. Railway	776
Track at Hamricks	710
Track at Reelsville	645
Surface of Eel river at Reelsville	610
Track at west line of Putnam county	670
Track at Eaglesfield	692
Track at Brazil	649
Track at Terre Haute depot	498
Low water Wabash river, Terre Haute	451

INDIANAPOLIS AND RICHMOND RAILROAD.

(P., C. & St. L. R. R.)

Track at Indianapolis Depot	721
Track at Greenfield	906

	Feet Above Ocean.
Track at Knightstown	916
Summit east of Lewisville	1,143
Track at Dublin	1,066
Track at Cambridge City	949
Summit west of Centreville	1,084
Track at Centreville	1,008
Track at Richmond	972
Track at Ohio and Indiana State line	1,026

LOUISVILLE, NEW ALBANY AND CHICAGO RAILROAD.

(*L., N. A. & C. R. R.*)

Indianapolis, Union Depot	721
Low water, Ohio river, at New Albany	365
Track at railroad depot	436
Track at New Providence	554
Track at top of knobs	718
Track at Pekin	609
Track at Red Cut (25½ miles)	835
Track at Harristown	875
Track at Salem depot	717
Track at Smedley depot	878
Track at Orleans	636
Track at Mitchell	665
Track at White river bridge	504
Track at Bedford	682
Track at Salt creek bridge	505
Water surface at Salt creek	471
Track at Harrodsburg	509
Track at Smithville	710
Track at Bloomington	745
Track at Bloomington Summit	883
Track at Ellettsville	685
Track at Gosport	574
Low water, White river at Gosport	557
Track at Quincy	752
Track at 129 miles, Putnam county	819
Track at Cloverdale	785
Track at Putnamville	690
Track at Greencastle Junction	776
Track at Greencastle L. & C. Depot	782
Track at Bainbridge	939
Track one mile north of Bainbridge (highest point on railroad)	955
Track at Whitesville	877
Track at Crawfordsville depot	744

	Feet Above Ocean.
Track at Lafayette depot	553
Water surface of the Wabash at L., N. A. C. Ry. bridge	511
Track at Chalmers	710
Water surface of Kankakee river	674
Track at Westville	789
Track at Michigan City depot	601
Surface of Lake Michigan.	585

GEOLOGY OF MONROE COUNTY.

BY GEORGE K. GREENE.

HISTORICAL.

Monroe county was named in honor of James Monroe, fifth President of the United States; and contains four hundred and twenty square miles, or two hundred and sixty-eight thousand, eight hundred acres. It is bounded on the north by Owen and Morgan; south by Lawrence; the east by Brown and Jackson; and west by Green and Owen counties.

The first settlement was made in the year 1816, by David and Jonathan Rogers, on the present site of Bloomington, the county seat—fifty-one miles south-southwest of Indianapolis—which was laid out in the year 1818, by Jonathan Nichols. The county was organized in the same year, the first circuit court being held in the open air. The present court house was built in year 1825.

The first settlers of Monroe county came from Grant and Clark counties of Indiana, and from Kentucky; and were soon increased in numbers by others from North and South Carolina, Virginia and Tennessee. Bloomington has now nearly four thousand inhabitants and is noted for its health, thrift and enterprise. It is situated on the Louisville, New Albany and Chicago Railway, one hundred miles north of Louisville, Ky., and, besides its many fine churches of various denominations, it contains the Indiana State University and many very substantial business houses enjoying a good and growing trade from the adjacent counties. It has two good flouring mills, one woollen mill, one steam furniture factory, one tannery, one spoke factory, one stave factory, one bent wood and stave factory, one foundry and machine shop, and plow factory, also one factory for jewelry and silverware.

The streets are wide and at right angles, well paved and adorned with numerous handsome dwellings. The city of Bloomington is 745 feet above the level of the sea.

STATE UNIVERSITY.

The State University and Preparatory College had an attendance last year of 341 students, viz: 161 at the former and 180 at the latter.

LIBRARY.

The library at present contains upwards of seven thousand volumes, more than a thousand of which have been added to it recently. The library room has also been greatly improved by additional shelving and the construction of a commodious gallery.

MUSEUM.

The museum has been thoroughly rearranged, and, in addition to the Owen collection and the Ward series of casts of fossils, many other objects of special interest to students and lovers of the science of geology have been lately added. The collection now numbers over one hundred thousand specimens of fossils and minerals, so completely arranged in accordance with their geological position that it is but the work of a moment to find any specimen desired. All the geological horizons of Europe are represented, and amongst the most notable is the original specimen of the *Ichthyosaurus communis*, from Boll, Wurtemberg, Germany, the largest and finest specimen of the kind ever found. Also the large fossil turtles (*Testudo oweni*) from the "Bad Lands" of Nebraska, figured in the Geological Reports of Iowa, Wisconsin and Minnesota, and all the other typical specimens figured by Dr. David Dale Owen in the same report; likewise the typical specimens figured by Professors Richard Owen and E. T. Cox in the Second Arkansas Report. They have been carefully arranged in separate cases. Also, nearly the entire skeleton of a *Megalonyx jeffersoni*, found near Henderson, Kentucky, and a remarkably fine half of a lower jaw, with the teeth attached, of the *Mastodon giganteus*, from Drennon Springs, Kentucky, found, mounted and presented to the museum by Prof. Richard Owen.

The Ward series of casts includes *Megatherium cuvieri, Mastodon giganteus, Glyptodon clavipes, Dinotherium giganteus*, and the *Colossochelys atlas*, the large turtle from the Sewalik Hills, India.

Considered as a whole, this magnificent collection offers a rich and rare intellectual repast, such as is seldom within the reach of those who can enjoy it best. To appreciate it properly, time is an essential element, and the careful student will never weary of examining and studying the wonderful and inexhaustible treasures of nature which are here displayed.

MINERALOGICAL.

The Mineralogical Department contains full suits of all the metallic ores, and is especially rich in rare specimens of *Gold, Platinum, Silver, Titanium, Iridium, Osmium, Tellurium, Yttrium, Rhodium, Cerium, Thorium*, and *Cadmium.* Also in such precious stones as the *Ruby, Emerald, Diamond, Garnet, Amethyst, Topaz* and *Carnelian.*

LABORATORY.

The laboratory, adjoining the museum, will readily accommodate forty students in qualitative analysis. The room on the second floor devoted to quantitative analysis has liberal accommodation for seven or eight students. Both laboratories are supplied with water, gas, hoods and all other requirements and conveniences. Adjoining the latter will be found the scale-room, which is liberally supplied with balances and all other essentials for the special use of advanced scholars. Full courses of lectures are given on qualitative, quantitative and blow-pipe analysis. The lecture room has been thoroughly remodeled, with raised seats, and will now seat seventy students comfortably. Apart from these there is another laboratory, skillfully constructed and arranged, specially fitted up for the use of students operating with the poisonous gases.

CAMPUS.

The spacious and beautiful campus has also shared in the general renovation, and is now entirely cleared of the old dead or dying trees which heretofore have so sensibly impaired its beauty. New trees have been planted and are growing vigorously; and, now, a representative of every species of the forest trees in the State of Indiana can be found upon the campus.

THE FACULTY.

LEMUEL MOSS, D. D., President, Professor of Mental, Moral and Political Philosophy.

THEOPHILUS A. WYLIE, D. D., Professor of Natural Philosophy.

DAVID S. JORDAN, M. D., Ph. D., Professor of Natural Science.

DANIEL KIRKWOOD, LL. D., Professor of Mathematics.

WALTER R. HOUGHTON, A. M., Principal of the Preparatory Department.

AMZI ATWATER, A. M., Professor of Latin Language and Literature.

GEORGE W. HOSS, LL. D., Professor of the English Language, Literature and Elocution.

THOMAS C. VAN NUYS, M. D., Professor of Chemistry.

HERMANN B. BOISEN, A. M., Professor of Modern Languages.

ORRIN B. CLARK, A. M., Professor of the Greek Language and Literature.

JOHN G. NEWKIRK, A. M., LL. D., Professor of History.

S. BROWN WYLIE, A. B., Assistant in the Department of Physics and Chemistry.

CHARLES H. GILBERT, B. S., Assistant in the Department of Natural Science.

COLLEGE OFFICERS.

Lemuel Moss	President.
Amzi Atwater	Secretary of the Faculty of Arts.
T. A. Wylie	Librarian.
D. S. Jordan	Curator of the Museum.
Thomas Spicer	Janitor.

COLLEGIATE DEPARTMENT.

Faculty of Arts.

Lemuel Moss, *President*,
Theophilus A. Brown,
David S. Jordan,
Daniel Kirkwood,
Amzi Atwater,
George W. Hoss,
Thomas C. Van Nuys,
Hermann B. Boisen,
Orrin B. Clark,
S. Brown Wylie.

BOARD OF TRUSTEES.

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A. L. Roache	Marion county.
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Under the flattering auspices of this able board of trustees, and a faculty adorned by the names of men long famous in their departments of science, both at home and abroad, we feel that it is safe to predict a grander future for our State University, and even a prouder record than that achieved in its honorable and illustrious past. The incubus of debt which so long pressed upon its vitals has been removed, and it is now free to pursue that high and noble career of usefulness for which it was designed by its original founders.

PALEOZOIC GEOLOGY.

SUB-CARBONIFEROUS.

CHESTER SANDSTONE.

The Chester sandstone appears in Bean Blossom township near the Owen county line and extends south through Richland, Van Buren and Indian Creek townships, overlying the upper Saint Louis group of rocks.

At Stanford, and also at Buena Vista, the Chester sandstone is the surface rock. This group consists of bright red and of light grey laminated sandstone; generally irregularly bedded and ferruginous.

The iron ore deposits of Indian Creek township belong to this group.

UPPER ST. LOUIS GROUP.

The upper St. Louis group of rocks enter the county near the line of Monroe and Owen counties running south through Bean Blossom, Richland, Bloomington, Van Buren and Indian Creek townships.

The rocks of this group, wherever they are exposed in Monroe county, are of a light grey color, regularly bedded, hard, silicious limestone; closely approaching in appearance and character to the lithographic limestone of Harrison county, and in some places contain a few fossils highly silicified.

LOWER ST. LOUIS GROUP.

Warsaw Division.

The lower St. Louis group of rocks lap up against the Keokuk group west of Wayport in Washington township, and run south through Bloomington township, cropping out on the hills north and east of the city of Bloomington; thence south they come to view as the surface rock at Smithville and also at Harrodsburgh.

This division is composed of limestone, chert and earthy layers. The famous building stone of Ellettsville, Stinesville, Bloomington, Bedford, Salem and Stockslagers in Harrison county, belongs to this division and is identical with the Oolitic limestone at Spurgeon Hill, so well known to collectors, for the immense number of finely preserved fossils contained.

The earthy and cherty layers contain irregular masses of chert, chert-bowlders and claystones. These claystones frequently owe their origin to the presence of minute marine organisms which, upon decomposition, have furnished a nucleus for the aggregation of silicious matter.

KNOBSTONE AND KEOKUK GROUPS.

The Knobstone and Keokuk groups of rocks enter Monroe county from Morgan on the north, and from Brown on the east; their western limits extending southward, appearing in Washington, Bloomington, Perry and Clear Creek townships.

The Keokuk group consists of a buff-colored limestone, with bands of chert and geodes; gray and bluish gray limestone, in the order named. The gray limestone is usually free from fossils. The bluish-gray limestone, however, is very fossiliferous, even in the partings which are quite numerous and from a few inches to three feet in thickness. The fossils found in the partings are notable for their fine state of preservation.

The Knobstone group consists of shales and sandstone. These shales are either of a bluish-gray or of buff color, and contain slight traces of the sulphate of lime and also of the sulphuret of iron. They also contain numerous fossils or internal casts, generally found in a silicified condition. In some localities great quantities of geodes occur from one to twelve inches in diameter, having their cavities filled with quartz and calcareous spar. The sandstone is either of a dark red, gray or buff color with horizontal partings ranging from a few inches to six feet in thickness.

GENERAL SECTION OF MONROE COUNTY.

	Feet.	Inches.
Chester sandstone and iron ore deposits..................	65	00
Upper St. Louis limestone and cherty layers............	35	00
Lower St. Louis limestone—Warsaw division..........	45	00
Keokuk limestone—buff colored..................	7	00
Keokuk limestone—light or bluish gray..................	23	00
Knob sandstone..	70	00
Knob shale—blue and buff colored.........................	130	00
Total..	375	00

WASHINGTON TOWNSHIP.

Section one-half mile northwest from Wayport.

Cherty and earthy layers..	12	00
Lower St. Louis limestone...	15	00
Limestone (Keokuk), light grey, containing with stems and plates of crinoids, *Aulopora gigas*, *Zaphrentis dalii*, *Z. cornucopia*, *Actinocrinus ramulosus* and basal plates of *A. lowi*.......	8	00
Limestone (Keokuk), buff colored..........	12	00
Knob sandstone, with partings..	30	00
Knob shale, with *Hemipronites cremstriatus*, *Spirifer carteri*, *Chondrites colletti* and *Vermiform fucoides*.......................	40	00
Total..	117	00

In the cherty and earthy layers numerous fragments of *Lithostrotion mammillare* and *L. proliferum* were seen. In a good condition the following fossils may be readily found, viz.: *Athyris trinuclea*, *A. hirsuta*, *A. lammellosa*, *Eumetria verneuilliana*, *Rhynchonella mutata*, *R. grosvenori*, *R. ricinula*, *R. sub cuneata*, *Terebratula bovidens*, *T. formosa*, *T. turgida*, *Sphenophoterium cuneata*, *Conocardium cuneata*, Plates of *Pentremites obliquatus* and *P. varsouvienesis;* also more perfectly preserved *P. conoideus*, *P. koninckianus*, *Batocrinus icosidactylus*, *B. irregularis*, *Alloprosallocrinus conicus*, *Dicocrinus constrictus*, *D. simplex*, bases of *Platycrinus saffordi*, *Syringopora ramulosa*, *S. multattenuata*, fragments of *Coscinium wortheni* and also of *C. michelinia*. Going northeast from Wayport, toward Hindostan, the surface rocks are of the Knobstone and Keokuk groups.

Mr. I. N. Corr, of Hindostan, has a good collection of crinoids from these beds in this locality. Among them the *Actinocrinus gouldi*, *A. lowei*, *A. humboldti*, *A. ramulosus*, *A. equalis*, *A. biturbinatus*, *Granatocrinus granulosus*. *G. ficus*, identical with those from the Burlington group. Also, *Pentremites burlingtonensis*. These are the only specimens I have seen from the Hindostan beds that are to be found at Burlington, Iowa. In the same collection he has the following fossils, viz.: *Spirifer carteri*, *S. pseudolineatus*, *S. neglectus*, *S. keokuk*, *S. fastigatus*, *Pleurotomaria shumardi*, Plates of *Archaeocidaris wortheni*, *Aviculopecten winchelli*, *Conularia sub carbonaria*, *Pinna sub spatulata*, *Platyceras equilatera*, *P. infundibulnm*, *Phillipsia bufo*, *Productus punctatus* and *P. altonensis*. Dr. A. E. Farr, of Hindostan, very kindly presented to me, for the State Museum, two very fine large crinoids of the species *Actinocrinus humboldti* and *A. lowii*.

Section at Hindostan.

	Feet.	Inches.
Earthy layers containing geodes	6	00
Limestone (Keokuk), dark gray	20	00
Limestone (Keokuk), light gray	10	00
Limestone (Keokuk), buff, fossiliferous	10	00
Clay, buff color, with geodes and stems and plates of crinoids	6	00
Limestone (Keokuk), buff color	10	00
Knob sandstone	20	00
Knob shale, containing *Choudrites colletti* and *Vermiform fucoids*	60	00
Total	142	00

Section on Bryant's Creek.

Section 2, township 10, range 1 west.

Surface soil of a creamy color	6	00
Limestone (Keokuk), dark blue	8	00

	Feet.	Inches.
Limestone (Keokuk), light gray	10	00
Limestone (Keokuk), buff, with bands of chert and geodes	6	00
Knob sandstone, with partings	20	00
Knob shale, containing *Vermiform fucoids*, *Hemipronites crenistriatus*, and casts of *Spirifer carteri*	80	00
Total	130	00

In the above dark blue Keokuk limestone the fossils were firmly imbedded and inaccessible to me, but enough of fragments sufficiently preserved were found to easily identify the following, viz: *Zaphrentis dalii*, *Z. cornucopia*, *Spirifer pseudolineatas*, *S. fastigatus*, single valves of *S. neglectus*, stems of *Scaphiocrinus*, stems and plates of *Actinocrinus lowei*, and *A. pernodosus.*

Section on Higgins' Branch.

Section 23, township 10, range 1 west.

	Feet.	Inches.
Earthy layers	12	00
Knob sandstones, irregularly bedded	40	00
Knob shale, containing the following geodized fossils: *Spirifer carteri*, *S. neglectus*, *Hemipronites crenistriatus;* also geodes containing chalcedony, botrioidal geodes and mammillated geodes, remarkable for their size and beauty	80	00
Total	132	00

MARION TOWNSHIP.

Section 4, Township 10, Range 1 East.

	Feet.	Inches.
Ferruginous clay soil	6	00
Limestone (Keokuk), dark blue	7	00
Clay parting, bluish gray	1	00
Limestone (Keokuk), light gray	5	00
Total	19	00

At the junction of the county roads, one-fourth of a mile southwest of Monroe's mill, on Hacker's creek, the creek bed and banks are thickly strewn with granite bowlders, of various sizes, to the county line, which was as far as my observation extended. Some beautiful specimens of sienite, greenstone, quartzite and flesh-colored feldspar were found.

On the Mahalasville road, one mile east from Monroe's mill, the Knobstone group is one hundreed feet in thickness, ten feet of which at its lower edge consists of clay concretions in globular and oval masses ranging from ten to thirty inches in diameter. These are firmly packed together by the weight of the superincumbent mass. In the branch at the foot of the hill are a number of granitic bowlders, varying in size from a few inches to more than one foot in diameter.

Three and one-half miles northeast of Monroe's mills, in a ravine running from Low Gap to Roberts creek, several large granitic bowlders may be seen, one of which is at least three feet in diameter above ground; its vertical exposure is thirty-eight inches. No bowlders are found south of Low Gap, in Marion township, except those which have evidently come from Brown county, through Wolf and Honey creeks; while on Honey creek black sand (magnetic iron ore) was noticed in several places, the same as the gold-bearing sand of Bear creek, in Brown county. Honey creek enters Marion township on the east side, three miles south of the Morgan county line. Its bed is very thickly strewn with granitic bowlders for several miles; these range from one to ten inches in diameter. All along its course beautiful geodes are found in great abundance, and the following finely geodized fossils, viz: *Hemipronites crenistriatus, Chondrites colletti, Spirifer carteri, S. neglectus,* Vermiform Fucoids and *Pentagonals.* For the latter the name *Geodocrinus Indianensis* is proposed. They are of various colors, from a dark gray to a light amber, and from one to seven inches in length. They doubtless owe their origin to some marine organism.

Mr. I. W. Corr, of Hindostan, has some very interesting specimens from this locality, among which, worthy of special notice, are several large geodized crinoids showing all the plates, with silica filling the interstices between the plates; one fine *Actinocrinus loweii, A. gouldi, Pleurotomaria Sp.?* and *Phillipsia bufo.*

On Wolf creek, a small stream heading in Brown county, black sand similar to that noted on Honey creek, was found.

Mr. Thomas Bates, who lives on the dividing ridge between Honey and Wolf creeks, has some very fine specimens of *Actinocrinus humboldti, A. lagunculus, A. equalis, A. biturbinatus, Platycrinus Sp.? Pleurotomaria Sp.?* and a magnificent large dark amber colored *pentagonal geode,* weighing about ten pounds.

BENTON TOWNSHIP.

Section at Unionville.

	Feet.	Inches.
Earthy layers, containing geodes and the following fossils: *Zaphrentis dalii, Z. cornucopia,* and plates and stems of crinoids	8	00
Limestone—Keokuk, bluish gray, containing a few internal casts of *Spirifer neglectus, S. fastigatus,* and *Zaphrentis dalii*	6	00

	Feet.	Inches.
Limestone—Keokuk, light gray	4	00
Limestone—Keokuk, buff color	6	00
Total	24	00

Section ———

(Section 8, township 9, range 1 east.)

	Feet.	Inches.
Earthy layers containing geodes and irregular masses of chert	6	00
Limestone—Keokuk, bluish gray with partings	10	00
Total	16	00

Here was found the following fossils, not however, in a very good condition, viz: *Forbeseocrinus multibrachiatus, Dichocrinus sculptus, Actinocrinus ramulosus;* plates of *A. humboldti;* and *A. lowei.* The following specimens from the same locality may be seen at the State University, namely: *Platycerus equilateralis, Productus punctatus, P. cora, Spirifer tenunstriatus, S. fastigatus* and *S. neglectus.* On Stephen's creek, geodes with crystals of dog-tooth and calcareous spar may be found. Occasionally large geodized crinoids of the the species *Actinocrinus humboldti; A. lower Hemi pronites crenistriatus, Spini fer carteri; S. tenuistriatus*, and some fine pentagonal *Geodoorinus indianensis.*

SALT CREEK TOWNSHIP.

(Section 27, township 8, range 1 east.)

	Feet.	Inches.
Clay soil, buff colored, very productive	6	00
Limestone, Keokuk, dark gray, containing *Zaphrenti dalii, Z. cornucopia, Actinocrinus equalis, A. ramulosus, Spirifer fastigatus, Productus punctatus, Platyceras equilateralis,* and fragments of *Pentremites woodmani*	7	00
Limestone, Keokuk, light gray	8	00
Limestone, Keokuk, buff color	10	00
Knob sandstone, irregularly bedded	40	00
Knob shale	80	00
Total	151	00

POLK TOWNSHIP.

Section on Gabe's Farm.

(Section 3, township 7, range 1 east.)

	Feet.	Inches.
Earthy layers containing geodes	6	00
Limestone, Keokuk, dark blue	10	00

	Feet.	Inches.
Knob sandstone, irregularly bedded	40	00
Knob shale	120	00
Total	176	00

CLEAR CREEK TOWNSHIP.

(Section 2, township 7, range 1 west.)

	Feet.	Inche
Argillaceous layers	12	00
Limestone, Keokuk, dark blue, with partings	12	00
Limestone, Keokuk, light gray, without fossils, save in a fragmentary condition	4	00
Limestone, Keokuk, buff colored with seams of chert and geodes	8	00
Knob sandstone, irregularly imbedded	30	00
Knob shale	70	00
Total	136	00

The argillaceous layers contain geodes and the following fossils, viz.: *Spirifer tenuistriatus*, *S. keokuk*, *S. fastigatus*, *S. pseudolineatus*, *Zaphrentis daili*, *Z. cornucopia*, *Productus punctatus*, *P. cora*, *P. altonensis*, *Actinocrinus lowei*, *A. laguncul us*, *A. pernodosus*, plates of *A. humboldti* and fragments of *Agaricocrinus tuberosus*, stems and plates of *Platycrinus*, also stems of *Scaphiocrinus* and good specimens of *Geodocrinus indianensis*.

Approaching Smithville from the east the Keokuk limestone becomes more massive and is overlaid by the Warsaw Division of the Lower St. Louis group.

SECTION ON FEE'S FARM.

(Section 10, town 7, range 1 west.)

	Feet.	Inches.
Argillaceous and cherty layers	10	00
Limestone (Warsaw Division), Lower St. Louis	25	00
Limestone (Keokuk), light grey, with partings	15	00
Total	50	00

These cherty layers contain *Lithostrotion mammillare*, *L. proliferum*, *Dichocrinus simplex*, *D. constrictus*, Plates of *Barycrinus*, Bases of *Platycrinus saffordi*, *Pentremites conoideus*, *P. koninckiana*, Plates of *P. obliquatus*, Plates of *P. varsouviensis*, *Spirifer lateralis*, *S. setigerus*, *S. rostellatus*, *Orthis dubia*, *Athyris hirsuta*, *A. lamellosa*, *A. trinuclea*, *A. royisii*, *Productus altonensis*, *P. punctatus*, *Rhynchonella mutata*, *R. grosevenori*, *R. Sub cuneato*, *R. ricunula*, *R. macra*, *Terebratula boyidens*, *T. turigida*, *T. formosa*, *Sphenophoterium cuneata*, *Syringopora ramulosa*, *S. multattanuata* and *Eumetria verneuilliana*.

The upper portion of the Warsaw division is a soft, friable, light-colored Oolitic limestone, containing fossils identical with those so numerous at Spurgen

Hill, as *Enomphalus planispira*, *E. spurgenensis*, *Rhynchonella subcuneata*, *R. grosvenori*, *Pentremites conoideus*, *P. koninckiana*, *Terebratula formosa*, *T. bovidens*, *Dichocrinus simplex*, and *Eumetria verneuilliana*.

In the partings of the light-gray Keokuk limestone are the following fossils: *Spirifer multilineatus*, *S. pseudolineatus*, *S. fastigatus*, *S. keokuk*, *Productus cora*, *P. punctatus*, *Platyceras infundibulum*, *P. equilateralis*; plates of *Pentremites woodmani*, *Actinocrinus*, *ramulosus*, *A. biturbinatus*; stems of *Scaphiocrinus*, and plates of *Platycrinus*, *Sp.?* Here, among fragments of fish-teeth, one tooth was found which was remarkable for its size and finely preserved condition.

These beds, and the locality east of Smithville, are very fossiliferous. Unfortunately they had been thoroughly overhauled by professional collectors just before my arrival, so that most of the specimens procured were mere fragments, although sufficiently preserved for accurate identification.

Section at Harrodsburgh.

	Feet.	Inches.
Ferruginous clay soil—suitable for bricks	4	00
Chert and earthy layers	6	00
Limestone, Warsaw division, lower St. Louis group	15	00
Limestone (Keokuk) dark-blue	10	00
Limestone (Keokuk) light-gray	12	00
Knobstone group	120	00
Total	167	00

Section at Harrodsburgh Depot—East Side.

	Feet.	Inches.
Argillaceous and cherty layers	6	00
Limestone with partings, Warsaw division, lower St. Louis	17	00
Limestone (Keokuk) dark and light-blue	38	00
Limestone (Keokuk) light-gray, containing *Spirifer keokuk*, *S. fastigatus*, and *Actinocrinus lagunculus*	6	00
Limestone (Keokuk) buff color, with bands of chert and geodes, the cavities of which are lined with beautiful crystals of quartz and calcareous spar. This strata contains plates and stems of crinoids; also fragments of shells, too imperfect, however, for accurate identification	8	00
Knobstone group	60	00
Total	135	00

Section at Quarry.

(Half mile southeast of Fairfax.)

	Feet.	Inches.
Bluish clay soil	6	00
Knob sandstone with partings	16	00
Knob shale	6	00
Total	28	00

The abutments of the new bridge crossing Salt creek, at Fairfax, are built of stone from the above quarry. The knob shale of this locality is almost destitute of fossils. Only a few impressions of *Vermiform fucoids* and *Hemipronites crenistriatus* were seen.

BLOOMINGTON TOWNSHIP.

Section at Gray's Mill.

(Section 2, township 9, range 1 west.)

	Feet.	Inches.
Dark, loamy soil	4	00
Knob sandstone, massive	30	00
Knob shale	40	00
Total	74	00

This is the only instance, in Monroe county, where the Knob sandstone is so massive.

The stone used in the abutments of the new bridge crossing Bean Blossom creek at Gray's mill is of a dark red color, due to the presence of iron. It is coarse-grained, very hard and durable, and was taken from a quarry one mile northwest of Gray's mill.

Section at Dunn's Quarry.

(Half a mile east of the city of Bloomington.)

	Feet.	Inches.
Ferruginous clay soil	4	00
Limestone, Warsaw division, lower St. Louis group, coarse grained and good for rubble masonry	5	00
Limestone, Warsaw division, light gray, fine grained, remarkably free from fossils, works freely under the chisel, bleaches white and hardens on exposure	6	00
Limestone, Warsaw division, lower St. Louis group, light gray in color, containing numerous small fossils (Spurgeon hill) highly silicified. This stone is too hard to be worked under saw or chisel advantageously, but is well adapted for rubble work in foundations and bridges	5	00
Total	20	00

Section at Railroad Cut.

(L., N. A. & C. R. R., one mile northwest of Bloomington.)

	Feet.	Inches.
Chert and argillaceous layers, containing *Athyris trinuclea*, *A. hirsuta*, *Zaphrentis spinulosa*, *Pentremites conoideus*, *P. koninckiana*, *Bellerophon sublævis*, *Dichoerinus constrictus*, *D. simplex*, fragments of *Lithostrotian mammillare* and *L. proliferum*	10	00

	Feet.	Inches
Limestone (upper St. Louis group) dark gray, hard and siliceous, closely resembling lithographic limestone, and containing *Terebratula bovidens*, *T. turgida*, *Athyris trinuclea*, *Syringopora multattenuata* and fish remains of the species *Palæoniscus*. One in a perfect condition, anatomically, may be seen in the Museum of the State University; another, in like condition, was found by Prof. Wylie. Both specimens were found at this place	10	00
Limestone (upper St. Louis group), light gray, hard and siliceous, weathering to a buff color under exposure to the action of the atmosphere, with horizontal partings.	25	00
Total	45	00

BEAN BLOSSOM TOWNSHIP.

Section at Big Creek Quarry, one mile west of Stinesville.

	Feet.	Inches.
Limestone (Warsaw Division, lower St. Louis group), light gray, clouded with bluish gray streaks, pleasing to the eye and susceptible of a high polish. It is excellently suited for interior decorations and monumental work generally, as may be seen at Stinesville, where Messrs. Hoadley & Litton have a turning lathe and saws in successful operation. This is a valuable bed of limestone, and quite accessible	4	00
Limestone (Warsaw Division, lower St. Louis group), coarse grained, light blue color, containing *Nautilus collectus*, *Bellerophon sublævis*, *Enomphalus planispira*, *E. spurgeonensis*, *Terebratula bovidens*, *T. formosa*, *T. sub cuneata*, *Rhychonella mutata* and *R. grosvenori*	2	00
Limestone (Warsaw Division, lower St. Louis group), light gray color, soft and easily worked, hardens on exposure, and is entirely without fossils	6	00
Limestone (Warsaw Division, lower St. Louis group), dark gray in color, very hard, and containing numerous small fossils highly silicified	8	00
Total	20	00

Section at McHenry's Quarry, half a mile west of Stinesville.

	Feet.	Inches.
Chert and argillaceous layers	8	00
Limestone (Warsaw Division, lower St. Louis group), light gray, fine grained, easily worked, without fossils, bleaches white and hardens on exposure. This stone is regularly bedded and accessible	15	00
Limestone (Warsaw Division, lower St. Louis group), dark gray, coarse grained and containing fossils silicified.	6	00
Total	29	00

Section at Davis & Cosner's Quarry, adjoining McHenry's Quarry on the north.

	Feet.	Inches.
Ferruginous clay, chert and argillaceous layers	8	00
Limestone (Warsaw Division, lower St. Louis group), dark gray, coarse grained, hard, water worn, containing numerous fossils in a silicified condition	4	00
Limestone (Warsaw Division, lower St. Louis group), light gray, fine grained, free of fossils and without partings or seams	30	00
Limestone (Warsaw Division, lower St. Louis group), dark gray, with numerous small (Spurgeon Hill) fossils	6	00
Total	48	00

Messrs. Baker & Pugh have a well appointed steam saw-mill in operation at Stinesville, employing twenty men sawing stone brought from these three quarries. They are now busy filling their contract for sawed and cut stone to be used in the new court house of Parke county.

Section at Allen's farm, on the Spencer road, three miles northwest of Ellettsville.

Section 31, town 10, range 2, west.

	Feet.	Inches.
Arenaceous soil	4	00
Chester sandstone, irregularly bedded unfossiliferous	40	00
Argillaceous and cherty layers, containing *Zaphrentis spinulosa*, *Athyris trinuclea*, *A. lamellosa;* spines and plates of *Archæcidaris Sp.? Syringopora multattenuata*, *Lithostrotion mammillare*, and fragments of *L. proliferum*	10	00
Limestone, upper St. Louis group, light-gray, hard, siliceous and regularly bedded	40	00
Total	94	00

RICHLAND TOWNSHIP.

Section at Perry Brothers' Quarry, one and a half miles north of Ellettsville.

	Feet.	Inches.
Clayey soil	4	00
Limestone—Warsaw division, lower St. Louis group—dark-gray, shaly and siliceous, containing the following fossils, viz.: *Nautilus collectus*, *Bellerophon sublævis*, *Orthoceras Sp.? Pleurotomaria wortheni*, *Terebratula formosa*, *T. turgida*, *Pentremites conoideus* and *P. varsouviensis*	8	00
Limestone—Warsaw division, lower St. Louis group—light-gray, fine grained, Oolitic, entirely without fossils	10	00
Limestone—Warsaw division, lower St. Louis group—dark-gray, very hard siliceous, Oolitic, containing fossils of the Spurgeon Hill varieties	2	00

	Feet.	Inches.
Limestone—Warsaw division, lower St. Louis group—light-gray, Oolitic, free from fossils, with a vein of *Stylolites* (called "toe-nails" by quarrymen) running through it horizontally	16	00
Limestone—Warsaw division, lower St. Louis group—dark-blue, Oolitic, remarkably free from fossils and susceptible of a good polish	8	00
Total	48	00

Perry Bros. have an excellently arranged steam saw-mill, and are well supplied with all the necessary apparatus and modern improvements for moving large blocks. Their usual working force is from forty to sixty men.

Section at Matthews & Son's Quarry, one mile north of Ellettsville.

	Feet.	Inches.
Ferruginous clay soil	5	00
Limestone—Warsaw division, lower St. Louis group—light grey, Oolitic, coarse grained and fossiliferous	6	00
Limestone—Warsaw division, lower St. Louis group—light grey, fine grained, regularly bedded, Oolitic, without fossils	16	00
Total	27	00

John Matthews & Son have a well arranged steam saw mill and steam channelling machine, besides all other necessary apparatus to facilitate the heaviest operations in their line of business. Their working force is usually from sixty to seventy men. They are now working another quarry nearer town, which, upon examination, was found to be substantially the same in stratification as the one given above; therefore, the section made of it is omitted.

Section at Sharp & Hight's Quarry, one mile north of Ellettsville.

	Feet.	Inches.
Ferruginous clay soil	5	00
Limestone, Warsaw division, lower St. Louis group, rough, shaly and much water worn, Oolitic, with many fossils of the Spurgeon hill species	10	00
Limestone, Warsaw division, lower St. Louis group, light gray, fine grained, Oolitic, without fossils	20	00
Total	35	00

The Oolitic limestones of Monroe county, by reason of accessibility and other valuable considerations, are of vast importance to the material prosperity and progress of the State of Indiana. For analysis of the same and other evidences of their superiority for building purposes, see Geological Report of Indiana for 1878, pages 95, 96 and 97.

Under the general heading of "building stone," same report, a great amount of valuable information will be found, arranged in a clear, concise and comprehensive manner. I am fully satisfied that they are worthy of all the high encomiums in their favor.

Section on the Hill road to Spencer, two and one-half miles west of Ellettsville.

Section 8, township 9, range 2 west.

	Feet.	Inches.
Arenaceous soil	4	00
Chester sandstone, unfossiliferous	30	00
Argillaceous and cherty layers, containing water-worn fossils in a fragmentary condition	10	00
Limestone, upper St. Louis group, light gray, hard and siliceous, resembling the lithographic limestone of Harrison county	40	00
Total	84	00

BUENA VISTA TOWNSHIP.

Section at Rocky Hill, on the Bloomington and Whitehall road, six miles southwest from Bloomington.

Section 4, township 8, range 2 west.

	Feet.	Inches.
Loamy soil, reddish color	4	00
Chester sandstone, bowlders and irregular masses of ferruginous sandstone	40	00
Argillaceous layers, containing irregular masses of chert, clay stones and fragments of fossils	10	00
Limestone—Upper St. Louis group—Light gray and shaly,	16	00
Limestone—Upper St. Louis group—Light gray, very hard and silicious, irregularly bedded and unfossiliferous	30	00
Total	100	00

Mr. J. L. Keith, who lives at the western foot of Rocky Hill, presented me with some fine specimens of *Lithostrotion mammillare* found at this locality.

INDIAN CREEK TOWNSHIP.

Section at the Old Iron Furnace, two and one-half miles southwest from Sanford.

(Section 7, township 7, range 2 west.)

	Feet.	Inches.
Pale red loamy soil	6	00
Chester sandstone, containing *Stigmaria ficoides* and *Calamites cannæformis* in a weathered condition	20	00
Argillaceous and cherty layers	10	00
Limestone (upper St. Louis group), light gray, hard, siliceous and irregularly bedded, containing *Zaphrentis spinulosa*, *Athyris trinuclua*, *Bellerophon sublaevis* and *Syringopora multattennata*	30	00
Total	66	00

RECENT GEOLOGY.

The bottom-lands of Monroe county, especially those along the creeks and water courses in the western tier of townships, are exceedingly rich and productive—due in a great measure to the abundant presence of plant food drawn from the rocky summits and wooded slopes of the uplands during long periods of time, and there deposited by the ceaseless operation of atmospheric agencies. The surface soils of the broad valleys of Bean Blossom and Salt creek are principally formed of sand and shale washed down from the knobstone and Keokuk groups. The fertile bottom-lands on Richland creek are composed of the disintegrated oolitic limestone and the rich overlying clays of the lower St. Louis group. The rich alluvial bottoms of Indian creek are largely composed of matter carried down from the Chester sandstone, upper St. Louis limestone and their super-incumbent clays.

LACUSTRAL DEPOSIT.

This interesting deposit is confined to a few localities, of limited area, in Monroe county; chiefly on Bean Blossom creek, and also at points along the line of the railroad in Bean Blossom township. These deposits, however, are mere traces of their ancient presence, and are not sufficiently marked to require more than a passing notice.

GLACIAL PERIOD.

Strong indications of the glacial period in Monroe county are found in Marion, Washington, Bean Blossom, Richland and Bloomington townships; principally, however, in its deposition of earthly matter, and in the construction of new and the modification of old water-channels; to meet the new requirements of the changed condition, topographically, of this region. The first tier of townships formed part of the southern rim of the great basin of the White river valley; the second tier formed the northern rim of the basin of the Bean Blossom creek valley, and, without doubt, Bean Blossom creek has once had its channel-bed much farther westward and nearer Ellettsville than we now find it flowing; at which time it doubtless found an outlet through Rocky branch, Jack's Defeat and Clear creek southward.

A careful observation and study of the topography and geology of this region renders the above conclusion a reasonable and legitimate inference on the premises.

* * *

It is emphatically true that, during one stage of the long-time consuming process, it found an important outlet for its swollen waters of melted ice by the way of Jack's Defeat creek, flowing to the southwest, and another, not less important for its purposes, through Clear creek valley, flowing southward to the Ohio river, over the present road-bed of the L., N. A. & C. R. R. In the valleys and along the water courses of Marion township, the indications of this period consist of moraines composed of Plutonic rocks, brought by the agency of ice, from regions far north of Indiana, which, after having been borne thus far towards the south, were left by the melting of the ice in the pocket-shaped recesses of the hills where we now find them, viz: one-fourth of a mile southwest of Monroe's mill (section 4, township 10, range 1 east) on Hacker's creek, and on the Mahalasville road (section 3, township 10, range 1 east), one mile east of Monroe's mill; also, in the only ravine running north from Low Gap to Robert's creek. In this ravine, one-half mile north of Low Gap, lies the large granitic bowlder, before referred to; much of its bulk is embedded in the earth, consequently the dimensions given only refer to the exposed part of it. The bowlder itself is at least seventy-five feet below the level of Low Gap, and its presence here to-day is, without a doubt, due wholly to that fact. It and its numerous companions were simply pocketed by the hills of this locality. The shaly character of the rocks throughout this whole region preclude the possibility of finding enduring striæ to indicate the local direction of the of the icy masses, but these deposits of Plutonic rocks tell their own eventful story to all who are competent to be their interpreters. Here, their long, slow and laborious journey ended; here, their mission as specially privileged ancient travelers began.

ECONOMIC GEOLOGY.

COAL.

It is practically useless and a waste of money, time and labor to indulge the fruitless dream of ever finding workable seams of coal in Monroe county. It does not exist here, except as a worthless, black, slaty coal-bone, traces of which may be found in Indian Creek township, running south through Lawrence, Orange and Harrison counties.

IRON ORE.

The only deposit of iron ore, of the least consequence for commercial purposes, is confined to a very limited area in Indian Creek township. Nearly forty years ago an iron furnace was erected by Randall Ross, of Virginia, on the lands of George Adams, of Monroe county, on section 7, township 7, range 2 west, which is about the center of the iron deposit. The investment soon proved a failure and the furnace has long gone to decay. This ore, though of good local repute, in the absence of stone coal, railroads, and other essentials, offers no inducement at present for its development. Iron ore does not occur in any other township in Monroe county, and this deposit is not of a character, either in quantity or quality, to justify any very brilliant anticipations in the future. The ruins of the "old iron furnace" are to-day the mournful monument of an early spirit of enterprise that deserved a better fate.

BUILDING STONE.

The building stone of Monroe county is worthy to be classed with the best in the State of Indiana; and, according to the careful scientific analyses and mechanical tests to which it has been officially submitted, it ranks with the best oolitic limestone in the world. (See Geological Report of Indiana for 1878, pp. 95, 96 and 97.)

GRINDSTONES.

Grindstones, for ordinary purposes, of an excellent quality, may be procured in unlimited quantities from the Knob sandstone on Bryant's creek, three miles northwest of Hindostan, section 2, township 10, range 1 west, where there is an open quarry. This stone varies in color from gray or white to a very pale red, with horizontal partings.

LIME.

Lime of a superior quality is extensively burned from the oolitic limestone at Bloomington, Ellettsville, and other places in Monroe county.

CLAYS.

Good clays for the manufacture of brick can be found in abundance at Harrodsburg, Bloomington and Ellettsville, and also at other points overlying the St. Louis limestones. Potters' clay of inferior quality may be found in several localities on Indian creek, Indian Creek township, and also on Honey creek, in Marion township.

KAOLIN.

Traces of kaolin—mere water-worn fragments—are occasionally found upon the surface. No beds of this deposit are found in Monroe county.

MINERAL SPRINGS.

With the exception of the "Old Salt Springs" on Salt creek (which, for many years, have ceased to flow), and Ketchum's Sulphur Springs, three miles southwest of Smithville, no other mineral springs of any importance are now known to exist in Monroe county.

AGRICULTURAL.

The topographical features of Monroe county are quite varied, and often of an imposing character. The townships of Washington, Marion, Benton, Salt Creek and Polk owe their soils principally to the disintegrated shales of the knobstone group, which, containing a great proportion of iron pyrites, renders it unfavorable for the production of hay; but good crops of wheat can be raised on this soil by the liberal use of fertilizers. The soils of Bloomington, Perry, Richland and Van Buren townships are very superior and quite different from the former; being composed in a great measure of the disintegrated rocks and overlying clays of the lower St. Louis beds, they are richer in stores of nutritious plant-food, and, therefore, are better adapted for all agricultural purposes.

That portion of Monroe county east of the L., N. A. & C. R. R. (more especially in Washington and Benton townships), has been robbed of its productive strength by reason of a want of proper attention to the succession of crops and use of fertilizers. I would very earnestly recommend the erection of suitable mills in the vicinity of the stone quarries for the purpose of crushing and thereby utilizing the waste stone, which, being nearly a pure carbonate of lime, will furnish a most excellent fertilizer at a nominal expense.

TIMBER.

The variety and quality of the timber in Monroe county will compare favorably with that of any other county in the State. At the time of the first settlement of Monroe county it was magnificently wooded with white and yellow poplar, white, red, black and chestnut oaks, white and black walnut, ash, cherry, chestnut, sugar-tree, beech, hickory, elm, sycamore, black and sweet gum, sassafras, dogwood, etc., much of which was wantonly wasted and destroyed in the original clearings. As the population increased the legitimate demands for timber of all kinds for different purposes, accompanied by reckless waste, soon made sad havoc with the grand old monarchs of the forest, so that now, save in some favored spots, the only timber of substantial value in the county owes its preservation to the physical difficulties of approaching the positions where it still so proudly stands. An active home and foreign demand for black walnut generally, and especially for such suitable to saw into veneers, has carried the very choicest specimens of this timber to Boston, New York and Philadelphia, and even to the principal capitals of Europe. When we consider that so much as two hundred dollars has frequently been paid for a single walnut tree suitable in size and figure for certain kinds of veneering, we can well imagine the loss Monroe county has sustained by indiscriminate clearings and their attendant burnings.

Vast quantities of cherry, ash and yellow poplar, of the finest quality and largest dimensions has, for many years past, been shipped by rail to Indianapolis, Cincinnati and New York, to be used in the manufacture of furniture and for other purposes. Immense numbers of staves and spokes are constantly required to meet the growing demand of the different factories here and elsewhere, even beyond the limits of the State. Those of Bloomington alone receiving, on an average, forty large wagon loads per day. The Standard Oil Company of Cleveland, Ohio, ships forty thousand dollars worth of staves from Monroe county, annually. A large and growing trade in tan bark and cross ties may be noted as a proof of the superior qualities of the timber of this county; all active agencies in its rapid disappearance.

FRUIT.

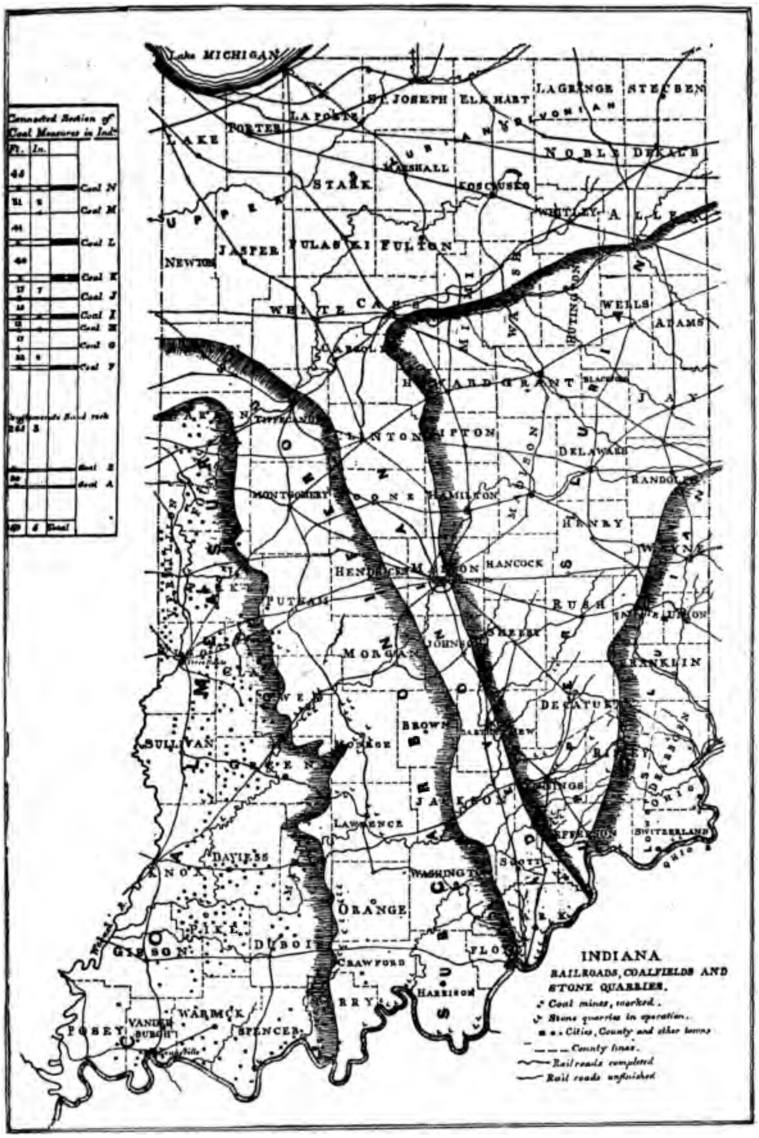
The cultivation of fruit is a notable feature wherever settlements occur throughout the county. That portion lying east of the Louisville, New Albany and Chicago Railway is peculiarly adapted to the growth of peaches, apples, pears, plums, cherries, grapes, etc. As for the small fruits generally, they are a safe crop in this region, enjoying all the advantages common to the whole of southern Indiana.

ANTIQUITIES.

With the exception of stone axes, arrow points, etc., of the pre-historic period of man on this continent, nothing of any special importance is to be found in the county. Particular pains, both by observation and inquiry, was taken to find earth-works, or other traces of the Mound Builders, but it was all in vain; not a single Indian mound is to be seen in Monroe county. From this fact it may be safely inferred that they never had any permanent habitation here. Their presence here, as travelers or hunters, is evident, however, from the numerons chippings of hornstone and chert which were observed near school house No. 4, Perry township; where several chert implements of rude construction, apparently derived from the cherty layers of this immediate neighborhood were found.

In this connection it may be proper to state that the beautiful symmetrical natural mound on Captain D. V. Buskirk's farm, on Bean Blossom creek, near its junction with White river, is not of Indian origin. Although it is often spoken of as being the work of the Mound-Builders, it is simply a natural mound formed exclusively by the action of water during the glacial period.

OUTLINE GEOLOGICAL MAP OF INDIANA.



MOLLUSCOUS FAUNA OF INDIANA.

SYNOPSIS OF THE

MOLLUSCOUS FAUNA OF INDIANA.

BY FREDERICK STEIN, M. D.

Since the molluscous fauna of Indiana attracted the attention of Thomas Say, that eminent naturalist, the interest in the study of the same has been steadily growing, until, at the present day, every species living within its borders is known to conchologists, and represented in each of a number of collections of mollusks in this State.

Many, probably the greater number of the mollusks occurring in Indiana, have been described in the early part of this century by Mr. Thos. Say, others by Messrs. Binney (father and son), Lea, Rafinesque, Barnes and others.

Some have not been known to exist within the limits of Indiana until very recently. *Unio purpuratus* was found in the Ohio river, near Mount Vernon, in 1873, and *Vivipara intertexta* in the stagnant waters of Posey, Gibson and Knox counties. Both of which species were, up to that time, considered as belonging to the fauna of the lower Mississippi.

In order to contribute to the knowledge of the natural history of Indiana, aud to aid young students in the study of mollusks; I propose to give here a systematic list of those living within the limits of Indiana, and a few general remarks as to the localities in which they are found.

All the land shells of Genera *Macrocyclis. Zonites, Strobila, Vallonia, Helicodiscus, Ferussacia, Pupa Vertigo, Succinea, Tebenophorus* and some of the Genus *Helix* (such as *H. multilineata, clausa* and *profunda,*) are common in low, damp land, along ponds, etc. The remaining species of *Helix* live on upland.

Most of them hide under flat stones, logs, chips and the dead leaves on the ground; some burrow in the ground, as for instance *Zonites fuliginosa*, *Z friabilis* and *Helix pennsylvanica.*

The non-operculated fresh water Univalves, *Vivipora* and *Melantho* prefer stagnant waters, while the *Valvata, Lioplax,* the *Rissoidæ* and *Itrepomadæ* are found in the large streams and rivers.

Many of the Unios seem to enjoy rapid streams, others are found exclusively in ponds and sluggish streams; many are found in almost any stream, others only in a few localities; while *U. sulcatus* and *perplexus* occur frequently in White river, they are very rare in the Wabash. *Anodonta suborbiculata* is found only in the ponds of Posey and Gibson counties, while *Anod. decora* occurs plentifully in any pond or sluggish stream.

Some like hard, gravelly ground and shallow water, as *U. rangianus* and *sulcatus, clavus*, etc.; others seek muddy ground and deep water, as *Unio retusus, Anodonta suborbiculata* and *Margaritana confragosa.*

UNIVALVES.

I. PULMONATA GEOPHILA.

HELICIDÆ.

a. *VITRININÆ.* Drap.

Genus MACROCYCLIS, Beck.

Macrocyclis concava..........Say.
All over the State in the woody lands.

Genus ZONITES, Montf.

Zonites fuliginosus..........Griffith.
In the valleys of Wabash and White rivers.

— ***friabilis***..........W. G. Binney.
Is found in considerable numbers in the counties bordering on the lower Wabash river.

— ***ligerus***..........Say.
Common all over the State.

— ***arboreus***..........Say.
Everywhere.

— ***minisculus***..........Binney.
Near Indianapolis.

— ***fulvus***..........Drap.
Found plentifully along the lower Wabash.

Genus LIMAX, Linn.

Limax campestris .... Binney.
Very common all over the State.

b. *HELICINÆ.*

Genus HELIX, Linn.

Sub-genus PATULA, Held.

Patula solitaria .... Say.
Along the lower Wabash and both branches of White river.

— ***alternata*** .... Say.
Common everywhere in the State.

— ***perspectiva*** .... Say.
Very common on woody hillsides.

— ***striatella*** .... Anth.
Near Indianapolis.

Sub-genus STROBILA, Morse.

Strobila labyrinthica .... Say.
Common in the low woods of the lower Wabash region.

Sub-genus POLYGYRA, Say.

Polygyra leporina .... Gould.
Found only in Gibson county.

Sub-genus STENOTREMA, Rafinesque.

Stenotrema stenotremum .... Fer.
In the vicinity of Indianapolis.

— ***hirsutum*** .... Say.
Common all over the State.

— ***monodon*** .... Rackett.
Common in all parts of the State.

— (Var.) ***leaii*** .... Ward.
In Posey county.

— (Var.) ***fraterna*** .... Say.
Common about Indianapolis.

Sub-genus TRIODOPSIS, Raf.

Triodopsis palliata .... Say.
A common species in low wood lands.

— ***obstricta*** .... Say.
Found only in Posey county, and there only in a few limited localities.

Triodopsis appressa..Say.
Not rare along with *Triodopsis palliata.* Near Bonebank, Posey county, found a small variety of this species very plentiful.

— ***inflecta***..Say.
Common in hilly wood lands.

— ***tridentata***..Say.
Most common on the hillsides along White and Wabash rivers.

— ***fallax***..Say.
Rather rare, yet often met with near Indianapolis.

Sub-genus MESODON, Raf.

Mesodon albolabris..Say.
In the low lands along the rivers.

— ***multiradiatus***..Say.
In the wood lands along the Wabash as well as White river, it is very common. In the vicinity of Indianapolis there is an unstriped variety found.

— ***pennsylvanica***..Green.
Common about Indianapolis; a very fine form of it is found in the valley of the Wabash.

— ***elevata***..Say.
A common species in Marion county.

— ***exoleta***..Binney.
Common in Marion county.

— ***thyroides***..Say.
Common everywhere.

— ***clausa***..Say.
Very common in Marion county.

— ***profunda***..Say.
Plentiful along White river and Wabash.

Sub-genus HELICODISCUS.

Helicodiscus lineatus..Say.
In low, damp woods.

Sub-genus VALLONIA, Risso.

Vallonia pulchella..Müller.
Common all over the State.

c. *ORTHALICINÆ.*

Genus PUNCTUM, Morse.

Punctum pygmæum..Drp.
— ***minutissimum***..Morse.
Near Indianapolis.

d. *PUPINÆ.*

Genus FERUSSACIA.

Ferussacia subcylindrica .... Linn.
In low, woody places in Marion county.

Genus PUPA, Drap.

Pupa pentodon .... Say.
Rare; occasionally in the low woodlands of Gibson county.

— ***fallax*** .... Say.
Common.

— ***armifera*** .... Say.
Common.

— ***contracta*** .... Say.
Very common.

— ***corticaria*** .... Say.
In great ers near Indianapolis, where they seem to have been introduced on building stone from the quarries south of Gosport.

Genus VERTIGO, Müller.

Vertigo ovata .... Say.
Not rare in the low woodlands along the lower Wabash.

e. *SUCCININÆ.*

Genus SUCCINEA, Drap.

Succinea ovalis .... Gould.
Common in many localities, but the finest and largest specimens of this species are found in Knox county.

— ***avara*** .... Say.
Very common about Bonebank, Posey county. Say's variety *vermeta* is sometimes met with in Marion county.

— ***obliqua*** .... Say.
Not rare in low, woody lands.

PHILOMYCIDÆ.

Genus TEBENNOPHORUS, Binney.

Tebennophorus carolinensis .... Bosc.
A common slug.

II. PULMONATA LIMNOPHILA.

AURICULINÆ.

Genus CARYCHIUM, Mueller.

Carychium exiguum..Say.
All over the State in low, damp and shady places.

LIMNÆIDÆ.

Genus LIMNÆA, Lamarck.

Limnœa stagnalis..Linn.
A circumpolar species, found in the lakes of the northern counties of Indiana.

— ***reflexa***..Say.
Common in all ponds.

— ***palustris***..Müller.
— (Var.) ***elodes***..Say.
Knox county.

- ***desidiosa***..Say.
Marion county.

— ***catascopium***..Say.
Not common.

— ***caperata***..Say.
Common in any ponds.

— ***humilis***..Say.
Marion county.

Genus PHYSA, Drap.

Physa gyrina..Say.
A most common species. Its variety, *Hildretheana* (Lea), occurs in Gibson county.

— ***heterostropha***..Say.
Common.

Genus BULINUS, Adanson.

Bulinus hypnorum..Linn.
Not rare; in some places plentiful. A very marked and large variety was found in Gibson county, about Coffee Chute.

Genus PLANORBIS, Guettard.

Planorbis trivolvis... ....Say.
Very common.

— ***bicarinatus***..Say.
Not quite so common as the preceeding.

— ***deflectus***..Say.
Marion county.

— ***parvus***...Say.
Not rare about Indianapolis.

— ***exacutus***... ....Say.
Near Indianapolis.

Genus SEGMENTINA, Flem.

Segmentina armigera... ....Say.
Common.

Genus ANCYLUS, Geof.

Ancylus tardus...Say.
In Wabash river and its tributaries.

III. PROSOBRANCHIATA.

VALVATIDÆ.

Genus VALVATA, O. F. Müller.

Valvata tricarinata..Say.
In the White and Wabash rivers.

VIVIPARIDÆ.

Genus VIVIPARA, Lam.

Vivipara subpurpurea.......... ....Say.
Common in the lower Wabash.

— ***contectoides***...W. G. Binney.
Lower Wabash river.

— ***intertexta***............ ....Say.
Gibson and Knox counties.

Genus MELANTHO, Borod.

Melantho ponderosa..Say.
In the Wabash river.
— ***decisa***.. ....Say.
In ponds in lower Wabash valley.
— ***rufa***.. Hald.
Found near Indianapolis.

Genus LIOPLAX, Troschel.

Lioplax subcarinata..Say.
Wabash river.

RISSOIDÆ.

Genus SOMATOGYRUS, Gill.

Somatogyrus isogonus..Say.
Common in the Wabash and its tributaries.
— ***integer***..Say.
Not common—rather rare.

Genus AMNICOLA, Ged. & Hald.

Amnicola granum.. Say.

Genus POMATIOPSIS, Tryon.

Pomatiopsis lapidaria..Say.
A very common species in the lower Wabash valley. It lives commonly on damp lands.

HELICINIDÆ.

Genus HELICINA, Lam.

Helicina occulta..Say.
Is to be considered extinct in Indiana, but it is found in a semi-fossil state in Posey and Sullivan counties.

STREPOMATIDÆ.

Genus ANGITREMA, Raf.

Angitrema armigera..Say.
Common in the lower Wabash.
— ***verrucosa***..Raf.
— (Var.) ***nupera***..Say.
Very common in the Wabash below Grand Chain.

Genus LITHASIA, Hale.

Lithasia obovata..Say.
Patoka creek, Gibson county.

Genus STREPHOBASIS, Lea.

Strephobasis curta..Haldem.
Wabash river.

Genus PLEUROCERA, Raf.

Pleurocera alveare..Conr.
Wabash river, from Grand Chain downward.

— ***undulatum***..Say.
Wabash and Ohio rivers.

— ***canalicalatum***..Say.
Wabash and Ohio rivers.

Genus GONIOBASIS, Lea.

Goniobasis depygis..Say.
Plentiful in the tributaries to Wabash.

— ***livesceus***..Menke.
Wabash and its tributaries.

Genus ANCULOSA, ——.

Anculosa praerosa..Say.
Very common about Coffee chute, in the Wabash river.

BIVALVES.

NAIADES.

Sub-genus UNIO, Retz.

Unio alatus..Say.
Ohio, Wabash and White rivers.

— ***lævissimus***..Lea.
Ohio and Wabash rivers.

— ***gracilis***..Barnes.
In almost every stream in Indiana.

— ***pressus***..Lea.
Ohio, Wabash and White rivers.

Unio multiplicatus..........Lea.
Ohio and Wabash rivers.

— ***undulatus***..........Barnes.
Ohio and Wabash rivers and their tributaries.

— ***plicatus***..........Lesueur.
Ohio and Wabash rivers and their tributaries.

— ***foliatus***..........Hildreth.
Ohio and Wabash rivers—rather rare.

— ***lachrymosus***..........Lea.
Ohio and Wabash rivers.

— ***asperrimus***..........Lea.
— ***quadratus***..........Say.
Ohio and Wabash rivers.

— ***fragosus***..........Conrad.
Ohio, Wabash and eastern branch of White river.

— ***cincinnatiensis***..........Lea.
— ***phillipsii***..........Conrad.
Both are now considered one species, the first the male, the last the female. Only few specimens of either have been found in the Ohio river, near Cincinnati.

— ***pustulatus***..........Lea.
Ohio and Wabash rivers and their tributaries.

— ***metaneverus***..........Raf.
(*U. nodosus* and *U. rugosus* of Barnes & Hildreth.) Ohio and Wabash rivers.

— ***wardii***..........Lea.
A variety of the preceding species, is found in the Ohio as well as Wabash river.

— ***cornutus***..........Barnes.
— ***reflexus***..........Conrad.
Ohio and Wabash rivers.

— ***pustulosus***..........Lea.
— ***verrucosus albus***..........Say.
— ***bullatus***..........Conrad.
Ohio and Wabash rivers.

— ***cooperianus***..........Lea.
Ohio river.

— ***verrucosus***..........Barnes.
— ***verrucosus purpureus***..........Hildreth.
— ***tuberculatus***..........Conr.
Very common in Ohio and Wabash rivers and their tributaries.

— ***graniferus***..........Lea.
Probably only a variety of the preceding species. Ohio and White rivers and their tributaries.

Unio irroratus .... Lea,
— ***stegarius*** .... Conrad.
Ohio and Wabash rivers.

— ***æsopus*** .... Green.
Ohio and Wabash rivers and their tributaries.

— ***varicosus*** .... Lea.
— ***cicatricosus*** .... Conr.
One of the rarer Unios, occurring in the Ohio and Wabash rivers.

— ***perplexus*** .... Lea.
Ohio and Wabash rivers, also in the eastern branch of White river.

— ***tuberculatus*** .... Barnes.
Ohio, Wabash and White rivers.

— ***cylindricus*** .... Say.
In any of the larger streams of Indiana.

— ***triangularis*** .... Barnes.
— ***formosus*** .... Lea.
One of the handsomest Unios in Indiana, occuring in the Ohio and Wabash rivers and their tributaries.

— ***elegans*** .... Lea.
— ***truncatus*** .... Say.
Common in the Ohio and Wabash rivers.

— ***donaciformis*** .... Lea.
— ***zig-zag*** .... Lea.
Ohio and Wabash rivers—rather plentiful.

— ***securis*** .... Lea.
— ***lineolatus*** .... Say.
Ohio and Wabash rivers.

— ***ovatus*** .... Say.
Common in the Ohio, Wabash and White rivers.

— ***rubiginosus*** .... Lea.
— ***flavus*** .... Conrad.
In any stream of the State.

— ***personatus*** .... Say.
(*Pileus*, Lea, is the male, while *personatus* is the female.) A very rare shell; Mr. Say described it from a specimen taken in the Wabash near New Harmony.

— ***trigonus*** .... Lea.
Ohio and Wabash rivers.

— ***solidus*** .... Lea.
Ohio and Wabash rivers.

— ***obliquus*** .... Lam.
Ohio and Wabash rivers.

Unio plenus........Lea.
Ohio and Wabash rivers.

— **pyramidatus**........Lea.
— **mytiloides**........Raf.
Ohio and Wabash rivers.

— **clavus**........Lam.
Ohio and Wabash rivers.

— **patulus**........Lea.
Probably a variety of the preceding species; found in great numbers in White river, near Indianapolis.

— **rangianus**........Lea.
Ohio, Wabash and White rivers.

— **sampsonii**........Lea.
A very marked variety of the preceding species; named in honor of the oldest living collector of mollusks in Indiana, Mr. James Sampson, in New Harmony.

— **sulcatus** (male)........Lea.
— **ridibundus** (female)........Say.
A rare species; found in the Ohio, Wabash and White rivers.

— **ellipsis**........Lea.
Wabash and Ohio rivers.

— **ventricosus**........Barnes.
A variety of Lea's *U. occidens*, Ohio river.

— **occidens**........Lea.
Ohio and Wabash rivers, also in White river.

— **capax**........Green.
In the Ohio and Wabash rivers.

— **multiradiatus**........?........Lea.
Ohio, Wabash and White rivers and their tributaries.

— **ligamentinus**,........Lam.
A common shell everywhere.

— **orbiculatus**........Hildreth.
— **abruptus**........Say.
Ohio and Wabash rivers.

— **luteolus**........Lam.
— **siliquoideus**........Barnes.
Ohio and Wabash rivers, but most plentiful in White river.

— **fabalis**........Lea.
Ohio, Wabash and White rivers.

— **parvus**........Barnes.
Ohio, Wabash and White rivers.

— **niggerrimus**........Lea.
White river.

Unio glans .... Lea.
Everywhere.

— ***circulus*** .... Lea.
Very common.

— ***lens*** .... Lea.
A variety of the foregoing species.

— ***rotundatus*** .... Lam.
— ***glebulus*** .... Say.
Ohio river.

— ***retusus*** .... Lam.
— ***torsa*** .... Raf.
Ohio and Wabash rivers.

— ***ebenus*** .... Lea.
Common in Ohio and Wabash rivers.

— ***subrotundus*** .... Lea.
— ***politus*** .... Conr.
Ohio, Wabash and White rivers.

— ***coccineus*** .... Lea.
Ohio, Wabash and White rivers.

— ***kirtlandianus*** .... Lea.
(A variety of *coccineus*, Lea's.) Ohio river, also White river, near Indianapolis.

— ***rectus*** .... Lam.
Ohio, Wabash and White rivers.

— ***anodontoides*** .... Lea.
— ***teres*** .... Raf.
Ohio, Wabash and White rivers.

— ***nasutus*** .... Say.
Ohio, Wabash and White rivers, the lakes and ponds in southwestern Indiana, and the canal near Indianapolis.

— ***novi-eboraci*** .... Lea.
The Indiana form of Lea's *Unio iris*. Wabash and White rivers.

— ***tennissimus*** .... Lea.
— ***velum*** .... Say.
— ***leptodon*** .... Conr.
Ohio and Wabash, and some of their tributaries.

— ***phaseolus*** .... Hildreth.
— ***planulatus*** .... Lea.
Common in the tributaries to the Ohio and Wabash, and consequently in these two rivers.

— ***gibbosus*** .... Barnes.
Very common anywhere.

Unio purpuratus .... Lam.
— ***lugubris*** .... Say.
Found only in the Ohio river near Mt. Vernon.

— ***monodontus*** .... Say.
Ohio and Wabash rivers.

Sub-genus MARGARITANA.

Margaritana complanata .... Lea.
Ohio, Wabash and White rivers.

— ***confragosa*** .... Say.
Ohio and Wabash rivers.

— ***marginata*** .... Say.
— [***Alasmodonta truncata*** .... Say.]
Ohio, Wabash and White rivers.

— ***rugosa*** .... Lea.
Ohio, Wabash and their tributaries.

— ***deltoidea*** .... Lea.
Ohio river.

— ***calceola*** .... Lea.
Wabash and White rivers.

— ***hildrethiana*** .... Lea.
Wabash and White rivers.

— ***dehiscens*** .... Say.
Wabash and White rivers.

Sub-genus ANODONTA.

Anodonta ferussaciana .... Lea.
Common in small streams and ponds.

— ***imbecilis*** .... Say.
— ***incerta*** .... Lea.
Common in ponds, lakes and canals.

— ***decora*** .... Lea.
Wabash and White rivers, ponds and canals.

— ***grandis*** .... Say.
In the lakes and ponds in southwestern Indiana.

— ***suborbiculata*** .... Say.
In the lakes and ponds of Gibson and Posey counties.

— ***subcylindracea*** .... Lea.
In any pond or lake of the State.

CORBICULADÆ.

1. *SPHÆRIUM.*

Sphœrium sulcatum	Lam.
— ***striatinum***	Lam.
— ***stramineum***	Conr.
— ***rhomboideum***	Say.
— ***partumcium***	Say.
— ***transversum***	Say.
— ***contractum***	Prime.

2. *PISIDIUM.*

Pisidium abditum	Haldem.

PALEONTOLOGY.

PALEONTOLOGY.

FOSSILS OF THE INDIANA ROCKS.

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INTRODUCTORY REMARKS.

It may be safely assumed, without imputing ignorance to any one, that a large proportion of the people of the State into whose hands this report shall fall, are not familiar with Paleontology, or *The science which treats of fossil remains,* nor with books in which the facts and conclusions of that science are recorded. Professor Collett, therefore, desires to have given in its pages an elementary chapter upon the subject of fossils in general and the practical advantage to be derived from their study, couched in familiar phrase which all can readily understand, and accompanied by figures of some of the more characteristic fossils of the Indiana rocks by which their kinds may be identified. No apology need be made for proposing and adopting such a course because the propriety of it is self-evident, even to those who do not themselves need it. Every scientist, however eminent, can well remember his own early beginnings and how thankful he then was for every word, printed or uttered, which would convey to him even a fragment of the knowledge for which he so eagerly thirsted, in language that he could comprehend, and it is the crowning glory of some eminent scientists that they are also admirable teachers of the young.

It will be impossible to present as much as an outline of the general subject with even approximate clearness in a single chapter, and I therefore propose to confine myself mainly to a brief popular explanation of the few fossils which have been selected for illustration upon the eleven plates which accompany this report; but before doing so it will be best to attempt a brief explanation of the character and conditions of preservation of fossils in general.

No animal or plant has ever been preserved in a fossil condition complete in all its parts, as it existed in life; and from the nature of the case, also, it is evident that only a small proportion of all the animals and plants that have formerly existed upon the earth could have escaped total destruction amid the changes which have successively taken place as the ages passed. The grass of the plains, the fallen trees of the forest, the bones and teeth of vertebrate animals and shells of mollusks, as well as the soft parts which accompanied them in life, when left lying upon the ground exposed to the elements, sooner or later decay, and leave no trace of their former existence; and it is only when imbedded in sediment at the bottom of waters that any remains of animals and plants have been preserved in the fossil condition. All the vast formations of stratified rocks are composed of such sediments in a more or less hardened condition, and in these are entombed the remains which reveal to us the former history of the earth, and the forms that have lived upon it.

In the case of plants it is the imprints of their leaves and other parts and their carbonized or mineralized stems which furnish us with our knowledge of the vegetation that formerly existed. The leaves, fruits and smaller branches have fallen into the water, settled upon its bottom and become covered by the constantly accumulating sediment; and ages afterward the strokes of the geologist's hammer brings them to light in the form of beautiful imprints upon the face of the riven rock. In some of the regions of the far west trunks of trees, sometimes forests of them, became submerged in waters which held silex in solution; and this silex so completely replaced the woody fibre by precipitation as the latter decomposed that the whole became a solid flinty mass. In many such cases, not only the form of the tree-trunks and branches is preserved, but even the microscopic structure of the woody fibre is often as clearly discernable as it is in the living wood of to-day.

While a mass of dead vegetation left exposed to the elements will become totally lost by decomposition, it will, if kept constantly covered in quiet waters, undergo a process of carbonization the results of which are familiarly known in the form of peat. The peat of former ages has been changed to coal. During the process of the preservation of these great accumulations of ancient vegetation, the plants which contributed their substance to the mass became so finely comminuted before solidifying as to retain little or no indication as to their kinds; but the sedimentary layers associated with the beds of coal usually contain scattered and more or less perfect parts of plants, which are doubtless of the same kinds as those of which the coal was formed.

In the case of animals it is only the hard parts, those which contain a greater or less proportion of mineral substances, which are preserved; such as the bones of vertebrate animals and the shells of mollusks. The soft parts of all animals always sooner or later decay and entirely disappear; and the form which these parts bore, and their relation to the hard parts which are preserved, must always be determined by a study of the latter in the case of all fossil or extinct forms. Thus we know the various kinds of mollusks which formerly existed by their shells alone; the crustaceans and insects by their crusts, or shelly coverings; fishes by their scales, teeth and bones; reptiles and mammalian quadrupeds by their bones and teeth; and none of them by their fleshy or soft parts, because those have wholly disappeared. It is a common, popular belief that the human body sometimes turns to stone after interment, but this is an error. The fat and muscular tissue, not only of the human body, but also of other animal bodies, in some cases changes, after death, to a wax-like substance called adipocere, and it is this which is mistaken for stone. This substance is tolerably firm, and often preserves the form and features of the body in a more or less perfect condition for a few years after death; but this only retards, and does not prevent, the final and complete decomposition of all those parts which were originally soft.

The substance of fossil bones, teeth, shells and coral is not usually found to differ materially from what it is in the living condition. Bones in the living animal consist of two-thirds mineral substances, and they are therefore preserved as fossils with comparatively little change. The shells of mollusks and the coral of polyps consist almost wholly of lime-carbonate, a substance identical with limestone, and they therefore undergo but slight change in the process of fossilization.

Sometimes, however, they change from that limestone condition to a silicious one, similar to that of the fossil wood already mentioned. The fossil coral figured on plate VI. has thus been changed to a silicious or flinty condition, while most fossil corals retain their original limestone-like condition. The numerous minute cavities which are seen in all cabinet specimens of the corals which live in the present seas, and which were filled with soft animal tissue in the living condition, have in fossil corals usually become so solidly filled with stony matter that they may be polished as marble; and yet the texture is so completely preserved as to show the structure of the fossil corals in as perfect condition as that of the living kinds.

It is not unfrequently the case that fossils, especially shells, are found in the rocks in the form of moulds and casts. The former are cavities from which fossils have been removed by solution, which did not effect the imbedding rock, and was effected by the percolation of water for a long time through the more or less porous rock which inclosed them. The latter consists of substances which have filled moulds once formed by solidification of dissolved mineral substances, or otherwise, and they are therefore counterparts of the original fossils. The following incident may serve as an illustration of these natural processes of fossil preservation:

During the excavations of the streets of Pompeii, the workmen came upon a cavity in the tufa or partially hardened volcanic ashes, which had for centuries lain upon the buried city. This cavity was found to be the mould of a human body, that of one of the inhabitants of the fated city who had fallen there from suffocation on that terrible night when the city was buried in a shower of ashes from Vesuvius. A plaster cast of this cavity was taken and the form of the doomed citizen was thus restored to human gaze just as it fell in death eighteen hundred years before. This is an impressive illustration, because it deals with catastrophe to human life, but the paleontologist not unfrequently, in a similar manner, restores to human view animal and vegetable forms whose kinds became extinct at a time compared with which that of the destruction of Pompeii was but yesterday.

The stratified rocks of Indiana belong to the earlier geological ages, called the Lower Silurian, Upper Silurian, Devonian and Carboniferous ages. The animal remains which they contain are, in many parts of the State, abundant, and consist almost wholly of those which lived in marine waters. We know this to have been the case notwithstanding the fact that they are now imbedded in the rocks of an inland portion of the continent and consist of species which are now extinct, because the kinds of living animals which are most nearly related to them are found only in marine waters.

Vegetable remains are rare or wanting in the rocks of the Devonian and Silurian ages, but they are so abundant in a large part of those of the Carboniferous age as to indicate the existence of a profusion of vegetation at that time which has never since been surpassed. Many of these vegetable forms were like the ferns of the present time; many were like certain portions of the vegetation which now characterizes Australia and neighboring islands, and some were strangely different from any living forms.

The remains of the most highly organized animals which have been discovered in the rocks of Indiana are those of fishes and reptiles, but these are very rare, and the most abundant fossils are shells, corals and the imprints of plants. Fossils of these latter kind are so abundant in Indiana that to illustrate even the principal forms that are now known would be a work requiring many years of labor, and many volumes. The few which are illustrated in this report have been selected from the more perfect examples of well-known kinds. Although they are valuable, so far as they go, they give at best only a faint glimpse of the treasures of this kind which the rocks of Indiana afford.

But some one will ask: "What is the practical value of all this, and what benefit is to be derived from a study of these things, which long since ceased to exist?" It may be answered much every way: Careful study of all departments of nature has an elevating influence, and ought to be publicly encouraged. But this does not quite answer the question in the form in which it is often raised, and I may, therefore, make the following statement of facts and legitimate inferences, as a partial answer, selecting those which are especially applicable to Indiana:

1. The rocks which underlie the surface of the State lie in more or less continuous layers, one upon another, constituting what are known as formations, portions of all of them respectively coming to the surface or near it in different regions, other portions of the same being elsewhere more or less deeply covered by those which overlie them as they lap upon one another. Thus, as one traverses the State in almost any direction he comes successively to regions where the rocks found at or near the surface are of different geological ages. Now, the kinds of animals and plants which existed in one geological age were different from all those which existed in any other age, and the geological age of any rock formation is known only by means of the fossil remains which are found in its strata. The chronological order of the formations thus established is so constant and reliable that the relative position of any formation in the scale is known with certainty, even though only a small portion of it may be visible at the surface, the remainder of the series being deeply covered or absent.

2. Although in other parts of the world coal is found in formations of other and later geological ages; in Indiana and the adjoining States it is to be found only in the coal-measures, or the upper formation of the Carboniferous age; and it is useless to seek for coal in any part of the State in which those rocks are found that, by their contained fossils, are known to belong to the Devonian, Upper Silurian or Lower Silurian ages, because these rocks all belong in the series beneath those which contain the coal. So also the lower Carboniferous rocks of Indiana are known to contain no coal; but the coal of the Upper Carboniferous formation, or coal-measures, has made the State famous for that feature of its mineral wealth.

3. Within the area then, which is occupied by rocks containing fossils that characterize the Upper Carboniferous formation, it is reasonable to search for coal. In all regions where Silurian, Devonian or Lower Carboniferous fossils are found in the rocks exposed at the surface, it is worse than useless

to make any such search. Thousands of dollars have been annually expended in the vain search for coal in regions where any one having a moderate knowledge of the rocks and their fossil contents, could have confidently predicted a failure.

It has already been stated that the rocks of Indiana belong to the earlier geological ages. Those of the later ages are found in the States which border the Great Gulf and the Atlantic, south of New York; and they also prevail over great areas in the western portion of North America, as well as in many other parts of the world. Therefore even the fullest illustration of the rich fossil treasures of Indiana would represent only a part of the full series of geological formations. Notwithstanding this fact, that part of the series which the State does contain is in some respects the more important one. Certain it is that the rocks of no State in the Union are more abundantly charged with fossil remains than those of Indiana, and some of the geological reports of other States are richly embellished with illustrations of beautiful and instructive specimens which have been obtained from rocks within her own borders.

Each of the species which are illustrated on the accompanying plates will be described on following pages in the usual technical language adopted by paleontologists; but preceding these descriptions the following popular explanation of the general character of the different kinds may not be inappropriate here:

The figures on plates I. and II. represent fossils of the lower Silurian age. All except figures 1 and 2 of plate I., and 1, 2, 3 and 4 of plate II., represent, by different views, respectively seven widely different species of a class of bivalves shells bearing the general name of Brachiopods. This class of animals was abundant and of many kinds in the seas of the earlier ages; but it has comparatively few representatives in those of the present time. Brachiopods differ from the ordinary bivalve mollusks in having the two valves of their shells more or less unequal, and also in other important particulars. The shells of this class are so abundant and varied in the different formations, and so characteristic withal, that they constitute valuable guides in determining the identity of the formations respectively in which they are found. Other bivalves, more nearly related to the clams of the present seas, existed at the same time with those which have just been mentioned, but the class of mollusks to which they belong was not nearly so full in those early seas as the Brachiopods were.

One species of these, distantly related to the pearl-oyster of the present seas, is represented by figures 1 and 2, of plate I.; and figures 3 and 4, of plate II., represent a species of Univalve mollusk which is too closely like many living forms to need explanation. Figures 1 and 2, of plate II., represent a kind of Crustacean, known by the general name of Trilobites (from the three-lobed character of the body), which were very numerous and of many kinds in the seas of the earlier geological ages. Every species of the whole Trilobite order has been extinct for ages, but the Horse-foot crab of the present seas so closely represents them as to enable us to judge very accurately as to the true nature of Trilobites. They had numerous weak legs, which are seldom found preserved, and some of them at least were in the habit of rolling themselves up like a ball, for purposes of protection by their firm outer crust. This position is shown by figure 2, on plate II., in which case the animal died in that posture of defense.

Plate III. represents a few kinds of the fossils of the Upper Silurian age. Figures 2 to 6 represent, by different views, two kinds of the bivalve shells called by the general name of Brachiopods, the general character of which has been explained, and the specific names, together with those of all the others will be found on subsequent pages. Figures 7 and 8 are two views of a Univalue shell having a general form which is not unlike that of many well known shells now living.

Figure 9 is that of a Trilobite of a different kind from that which is illustrated on plate II. The general character of these animals has already been explained. A person unacquainted with such forms as are represented by figure 1, which belong to an order of animals called crinoids, could hardly be persuaded that it is not a representation of some vegetable instead of animal form. It is seen to have a root, by which it was attached to the bottom, a stem, and what appears to be a flower at the top; and the stem of some of the species is profusely branched, which adds still further to their vegetable-like aspect. Notwithstanding all this, no fact in natural history is more clearly established than that the crinoids are animals and not vegetables; the structure of their bodies, or the part which resembles a flower, being similar to that of the star-fishes, to which, indeed, they are very closely related. Several species of crinoids have been found alive in the present seas, but they are not now nearly so abundant as they were in the seas of the earlier geological ages. Many of their forms are of remarkable beauty and they often covered great areas at the bottom of those ancient seas, forming submarine animal-flower gardens which were the rivals in variety and beauty of those which we now admire in the vegetable world. So abundant were they in some places then that great layers of rock are often found made up almost entirely of their remains, which are similar in their composition to that of shells and corals.

The figures on plates IV. and V. represent fossils of the Devonian age. All the figures on plate IV. and figures 7 to 12 inclusive on plate V., are those of seven different species of Brachiopods, the general character of which order of shells has already been explained. Figures 5 and 6 on plate V. are two views of one and the same shell which represents a species belonging to the same great class with the common clam. Figures 1 and 2 of the same plate are two views of a small broken mass of fossil coral, which consists of numerous small angular tubes in close contact with each other, and having numerous small holes or pores communicating through their walls. One oi the figures shows the sides of the tubes, which are exposed when the mass is broken apart, and the other their ends. In figures 3 and 4 on plate V. represent another and very different coral. It is shaped like a small horn, and has a moderately deep cup-shaped cavity at the larger end.

Corals are found in rocks of marine origin belonging to all the geological ages, but they were particularly abundant in the seas of the Devonian age. One of the great coral reefs of that age now obstructs the navigation of the Ohio river opposite Jeffersonville, producing the falls of the Ohio. These ancient corals have become consolidated into ledges of limestone, but it is nevertheless as veritable a coral reef which obstructs the river navigation there, as those are upon which ships are wrecked in the seas of to-day.

Plates VI. and VII. represent fossils of the Sub-carboniferous group, or the lower formations of the Carboniferous age. Figures 1 and 2 of plate VI. are side and top views of a fragment of a mass of coral of a kind which is very common in some parts of the State, and is quite characteristic of a part of the Sub-carboniferous strata. The masses are often large and are usually found to have been changed to a hard, flinty condition. Figure 3 is that of a species of Crinoid, the general character of which plant-like animals has been already explained. Figure 4 represents the shell of a swimming mollusk, representatives of which class now live abundantly, although usually of much smaller size, in the open ocean. Figure 5 is that of a Trilobite, one of the last of its kind, for the remains of these creatures, although so common in the earlier formations, are not found in any rocks of later age than the Carboniferous. Figures 1 and 2 of plate VII. are two views of a large Brachiopod, the general characteristics of which class have already been explained. Figure 2 represents the appearance of the stony filling of the shell from which the *test* has been removed and exhibiting the large scar of attachment of the muscles by which the animal opened and closed its shell. Figures 3 and 4 are two views of a shell related to the Pearly Nautilus, the zig-zag lines showing the position of the septa or partitions by which the shell was divided into chambers, in the outer one of which the animal lived. Figure 5 represents a univalve shell of a kind that is somewhat common in the Sub-carboniferous rocks, and figures 6, 7 and 8, three species of Crinoid, the general character of which has already been explained. Figures 9 to 12 represent three kinds of Pentremites, which are animal forms closely related to the Crinoids. Like the Crinoids, they were attached to the bottom or some other object by a slender stem of greater or less length, but the body was not provided with petal like arms, as most Crinoids were.

Plate VIII. represents fossil shells of the coal measure rocks, or those of the formation which contains the coal. Figures 1 and 2 represent a kind of bivalve shell, the form of which may be readily understood from the figures although the specimen from which they are drawn has been somewhat distorted by accidental pressure. Figures 3 and 7 and 8 represent two widely different kinds of Brachiopods, which two kinds are among the most characteristic fossils in the Coal-measure formation. Figures 6 and 4 and 5 represent two characteristic kinds of univalve shells.

Plates IX., X. and XI. contain figures of fronds or leaves of different plants of the fern kind, which are more or less common in strata associated with the coal. These, as well as the fossils of the other plates are all minutely described on following pages under the names that have been given them by paleontologists, and the localities in Indiana at which they have been found is also given in the same connection. The few kinds of fossils represented on these plates are not a tithe of those which are well known in the rocks of Indiana, but such interests cluster around them that surely one can not look upon them without a strong desire to know more about the strange forms which have once peopled our earth but are now extinct.

DESCRIPTION OF FOSSILS.

In presenting the fiew species of fossils, described on the following pages, and illustrated on the accompaning plates, no claim is made to any original work, or observations on my part, in connection with the greater portion of them. All the species except the three, which have been lately published by myself, have long been well known to geologists, through the publications of different authors; and it is for this reason that they have been selected for illustration and description here, as being more instructive than new and rare forms would be. I have not thought it necessary in this case to precede each description with extended synonymy and references to the numerous works in which some of the species are published; and I have therefore confined myself to a single reference of that kind in each case; which reference is not always to the original publication. In case the description is quoted verbatim, it is the work thus refered to that the quotation is made from. Those descriptions which are quoted, are indicated by the usual quotation marks, and the author's name is added at the end in brackets; but in a few cases I have re-written the description, of long published species. In several cases I have chosen to copy the specific descriptions which have been given by subsequent authors rather than those of the original authors; because it is thought that the later descriptions are more nearly adapted to those varieties of the respective species which are found in Indiana, since they were drawn from specimens that were obtained from rocks of this and adjoining States.

The illustrations have all been drawn anew by Dr. J. C. McConnell, of Washington, D. C.; the greater part of them having been drawn directly from specimens collected within the limits of Indiana, and identified by means of their respective original descriptions and figures. The drawings have all been made with pen and ink, and reproduced for printing, by the new process of the Photo-Engraving company of New York City.

The fossils used for this purpose have been borrowed from the private cabinets of Mrs. Mary P. Haines, of Richmond; Hon. John T. Scott, of Terre Haute; Mr. Geo. K. Green, of New Albany; Mr. William Gibson, of Newport; Mr. V. W. Lyon, of Jeffersonville; Dr. James Knapp, of Louisville, Kentucky; Mr. Wm. Gurley, of Danville, Illinois; and Prof. John Collett. The remainder of the drawings are copies of published illustrations of Indiana fossils, which have appeared in Geological reports of other States, which specimens were chosen by their authors as being better suited for that purpose than any of those, which have been discovered in the corresponding formations within the limits of those States.

LOWER SILURIAN.

MOLLUSCA.

BRACHIOPODA.

GENUS STROPHOMENA, Rafinesque.

Strophomena alternata, Conrad.

PLATE I, FIGS. 6 AND 7.

Strophomena alternata. Meek 1873, Paleontology of Ohio, Vol. I, page 881.

" Shell attaining a large size, semi-oval, the breadth being nearly always greater than the length, but varying from about equal to the latter to the proportions of near nine to seven; hinge line as long as the breadth of the valves at any point farther forward, or somewhat longer; lateral extremities rectangular, or a little more or less than rectangular; sometimes compressed and moderately deflected; lateral margins straight, a little convex, or slightly sinuous posterorly, and rounding forward to the front, which is semi-circular in outline, or sometimes so prominent and narrowly rounded in the middle, as to impart a sub-trigonal form to the general outline of the valves.

Dorsal valve flattened in the umbonal and cardinal regions, and gently or more or less strongly concave in the central and anterior portions, and curved upward around the anterior and lateral margins; beak small, but projecting slightly beyond the edge of the area, which is very narrow, or sub-linear and directed nearly backward. Interior with cardinal process strong, directed obliquely forward, with its two divisions distinctly diverging, and flattened and longitudinally striated on their posterior faces; sockets for the reception of the teeth of the other valve rather well defined; socket ridges very small, and uniting behind the cardinal process to form a kind of false deltidium; muscular scars comparatively small, but deeply impressed near the cardinal process on each side of a small, short, mesial ridge, and nearly surrounded by a low obtuse ridge formed by the thickening of the adjacent internal surface of the valve; anterior and lateral margins more or less thickened and geniculated within (especially in adult shells), the thickened zone being transversely furrowed, and sometimes granular, while outside of it the immediate edge of the valve is suddenly flattened, and minutely striated and granulated.

Ventral valve a little convex at the umbo, but generally much compressed over the whole visceral region, in the adult (which includes the whole surface of the young and half grown shell) but becoming more convex (sometimes strongly so) anteriorly, or anterio-centrally and laterally, and thence more or less curved up to the anterior and lateral margins; area of moderate hight, flat and directed obliquely backward nearly at right angles to that of the other valve; beak very small, scarcely distinct from the margin of the area, and minutely perforated; foramen broadly triangular, and arched over above by the pseudo-deltidium, which is very deeply sinuous on its inner edge, the sinus being nearly or quite closed by the dental process and pseudo-deltidium of the other valve.

Interior with cardinal margin somewhat carinate within; hinge teeth moderately prominent, remote and widely divergent; dental ridges obscure and extending obliquely outward and forward, but not produced or curving to surround a saucer shaped cavity for the muscular scars; scars of adductor muscles narrow, long and closely approximated, or almost in contact; those of cardinal muscles on each side very large, fan-shaped but shallow, separated sometimes by a small ridge in advance of the adductor scars, and marked by radiating furrows and ridges; while the anterior and lateral regions are usually marked by striæ and scattering granules.

Surface of both valves ornamented with numerous radiating strtæ, that increase in number on the ventral valve, mainly by intercalation, and are usually arranged with one to six or eight smaller or shorter ones between each two larger and more prominent ones, the largest one of which often occupies the mesial line; while on the dorsal valve they more frequently increase by division, and are generally of more uniform small size.

On well preserved specimens all the radiating lines are crossed by numerous very minute, regular, closely arranged concentric striæ, that are invisible without the aid of a magnifier; a few moderately distinct, sub-imbricating marks are also often seen near the free margins of adult shells.

Length of a rather large specimen (of medium convexity), 1.52 inches; breadth, 1.84 inches; convexity, 0.36 inch." [Meek.]

Position and locality: Cincinnati group; Richmond, Indiana; cabinet of Mrs. Mary P. Haines.

Strophomena planumbona, Hall.

PLATE II., FIGS. 13 AND 14.

Strophomena Planumbona, Meek. Paleontolgy of Ohio, Vol. I, p. 79.

"Shell rather small, or scarcely attaining a medium size, concavo-convex, semi-oval, or more than semi-circular in outline; hinge line generally a little longer than the breadth of the valves at any point farther forward; lateral extremities, in most examples, somewhat less than rectangular, or sometimes rather acute, more or less compressed and deflected; lateral margins a little contracted posteriorly, and rounding to the front, which forms a regular semicircular curve. Dorsal valve flat in the umbonal region, and rather strongly and evenly convex in the central and anterior regions, from which it rounds off abruptly to the front and lateral margins; beak very small, or not distinct from the edge of the narrow or sublinear area, which is inclined nearly directly backward, but not incurved. Interior showing the cardinal process to be small, depressed, divided to its base into two diverging tooth-like parts, a little flattened on their posterior faces, and directed very obliquely forward and outward; socket ridges short and oblique; mesial ridge low, extending but a little distance forward; while the space between it and the socket ridge, on each side, is occupied by a moderately distinct muscular scar.

Ventral valve broadly and rather deeply concave in the central and anterior regions, and slightly convex at the beak, which is very small, abruptly pointed, scarcely projecting beyond the edge of the area, and usually minutely perforated; area moderately high, extending the whole length of the hinge, generally but little sloping laterally, flattened and inclined more or less backward; foramen closed by a prominent rounded pseudo-deltidium, that is transversely striated, and rather broadly sinuous on its inner edge, for the reception of the cardinal process of the other value. Interior showing hinge teeth to be well developed, trigonal and striated on their posterior sides; while from their inner bases the dental laminæ extend forward so as nearly to encircle the usual saucer-shaped depression for the muscular scars, which is sometimes divided by a small, linear mesial ridge; cardinal margin prominent and sharp within, on each side of the hinge teeth; anterior and lateral regions more or less thickened within, and roughened by the crossing of the vascular markings, which are scarcely visible on any part within this zone.

Surface of both valves ornamented by numerous fine, closely crowded, radiating striæ, that are often alternately a little larger and smaller, or on some parts, with several of the smaller ones between each two of the larger;

the smaller being always shorter than the larger, or ending at various distances between the free margins and the beaks, without coalescing with those between which they are intercalated. Striæ and furrows minutely crenulated by extremely small, very regular, closely arranged, concentric lines, invisible without the aid of a magnifier; a few sub-imbricating marks of growth are likewise sometimes seen near the free margins.

"Length of a medium sized specimen, 0.73 inch; breadth, 0.98 inch; convexity, 0.24 inch; number of striæ in the space of 0.10 inch near the middle of the front margin, from 5 to 8; the greater number being where smaller ones are intercalated between the larger." [Meek].

Position and locality: Cincinnati Group; Richmond, Indiana; cabinet of Mrs. Mary P. Haines.

Genus ORTHIS, Dalman.

Orthis subquadrata, Hall.

PLATE I, FIGURES 3, 4 AND 5.

Orthis Subquadrata. Meek, 1873, Paleontology of Ohio, p. 94.

"Shell attaining about a medium size, rather distinctly resupinate, somewhat wider than long, subquadrate in general outline; moderately convex; cardinal margin shorter than the breadth of the valves, and rounding abruptly at the extremities into the lateral margins, which round and converge forward; front a little sinuous or straightened at the middle.

Dorsal valve more convex than the other, its most prominent part being near the middle; mesial sinus small, and rather shallow, sometimes continued back nearly to the umbo, or in other instances scarcely more than reaching the middle; beak very short, or a little distinct from the edge of the area, and more or loss arched; area narrow, directed obliquely backward and downward. Interior with scars of the adductor muscles moderately distinct, the posterior pair being situated close back under the brachial processes, one on each side of a well-defined rounded ridge, that becomes suddenly smaller between the anterior pair; cardinal process rhombic, sub-conical, moderately prominent, and having its posterior side marked by deeply impressed divaricating striæ; sockets well defined; brachial processes rather strong and directed obliquely forward and laterally; internal surface, excepting the radiately striated front and lateral margins, nearly smooth.

Ventral valve a little convex at the umbo, and flat, or slightly concave, between the umbo and the front and lateral margins, but sometime having a low, very obscure mesial elevation toward the front; beak small, and very short, or scarcely equaling that of the other valve, arched at the apex, but not strongly incurved; area about twice as high as that of the other valve, well defined, tapering rather rapidly toward the lateral extremities, arched with the beak, and directed backward and downward at decidedly less than a right angle to that of the other valve; foramen broad-triangular, and partly occupied by the cardinal process of the other valve. Interior with muscular scars occupying a rather deep, bilobate impression extending nearly or quite to the middle of the valve, and usually defined by a low ridge most distinct on each side; scars of adductor muscles small, separated by a mere trace of a raised line; those of the divaricator muscles of moderate size, longitudinally striated, and having their narrowed posterior ends extending backward nearly to a small, triangular, transversely striated space occupying the interior of the beak; those of the ventral adjustor muscles smaller and shorter than the divaricators, and situated nearly under the hinge teeth, which are moderately prominent, sub-trigonal and oblique; vascular markings with their lateral divisions curving up backward and sending off several branches, while the other divisions extend forward and bifurcate so as to occupy the anterior region; anterior and lateral margins crenate within by very short striæ.

Surface of both valves ornamented by moderately stout, radiating straiæ, the posterior lateral of which curve so strongly outward that a few of them run out on the cardinal edge before reaching the lateral margins; striæ of ventral valve nearly always increasing by bifurcation (some of them dividing two or three times); while those on the dorsal valve generally increase by the intercalation of shorter ones between the longer. A few distant, sub-imbricating marks of growth are sometimes seen toward the front and lateral margins; while on perfectly preserved specimens, the radiating striæ may sometimes be seen to be roughened by minute elevated concentric lines, that are more or less interrupted in crossing some of the striæ.

Length of a rather large, well developed specimen, 0.96 inch; breadth, 1.30 inches; convexity, 0.43 inch." [Meek].

Position and locality; Cincinnati Group; Richmond, Indiana, Cabinet of Mrs. Mary P. Haines.

Orthis occidentalis, Hall.

PLATE II., FIGURES 10, 11 AND 12.

Orthis Occidentalis. Meek, 1873, Paleontology of Ohio, p. 96.

" Shell attaining a moderately large size, wider than long, varying from transversely sub-quadrate to semi-oval, becoming quite gibbous with age; hinge line exceeding, about equaling, or sometimes a little less, than the breadth of the valves at any part farther forward; lateral extremities moderately compressed, varying from rather acutely to more or less obtusely angular; lateral margins often a little sinuous behind, but sometimes straight or convex in outline, but rounding to the front, which is nearly always a little sinuous, and some times rather decidedly so, in the middle.

Dorsal valve more convex than the other, especially in the large adult examples, its greatest convexity being generally a little behind the middle, on each side of a shallow, undefined mesial sinus, generally extending from the front to the umbonal region, but sometimes nearly or quite obsolete, or only represented by a slight flattening along the middle; swell of the umbo comparatively prominent, and often projecting backward further than the beak of the other valve; beak rather strongly incurved; area of moderate hight in the middle but sloping to the lateral extremities, sharp along the margin, and more or less strongly incurved; foramen broad-triangular, and not closed by the cardinal process. Interior with scars of the adductor muscle situated on each side of a low mesial ridge, which is narrower between the anterior than the posterior pair, which latter are placed far back under the brachial processes, and rather strongly striated, but without well defined margins; anterior pair somewhat trigonal, and usually each separated from the posterior by an obscure transverse ridge, but without well defined anterior margins; cardinal process merely presenting the appearance of a compressed or sharp ridge, much lower than the surface of the cardinal area; sockets distinct; brachial processes directed forward and more or less laterally, usually sharp on their inner under edges; vascular scars unknown.

Ventral valve most convex at or near the apex of the beak, from near which it slopes more rapidly to the front and lateral margins than to the anterior lateral, the anterior region being impressed so as to form a broad, more or less deep, undefined mesial sinus, that dies out before reaching the umbo; beak rather elevated, but not projecting backward, abruptly pointed, very nearly straight, or sometimes slightly arched at the point; cardinal area rather high at the beak, but sloping to the lateral extremities, flat or slightly arched, and usually standing nearly at right angles to the plane of the valve; foramen generally higher than its breadth at the hinge line, and extending to the apex of the beak. Interior showing the cardinal margin to be prominent and sharp, and the hinge teeth well developed; cavity for the reception of the muscular scars deep, nearly or quite reaching the middle of the valve, obcordate in form, and bounded by a prominent ridge continued forward from the bases of the hinge teeth, and curved a little backward at the central point of the front, where they meet; impressions of the divaricator muscles (cardinal, of some) deep; while those of adjustors are so small, and pushed so far aside, as to occupy the sides of the dental plates, and thus to be out of sight in a direct view; those left by the adductors are narrow, elongated, and situated on each side of a mesial ridge, that is divided along the middle so wide and distinct a furrow as to appear almost like two linear ridges; transversely striated cavity within the beak, white, very small and broad-triangular; free margin crenate within, while the surface between this and the deeply impressed muscular cavity is usually smooth, or sometimes very minutely and obscurely corrugated; vascular markings unknown.

Surface of both valves ornamented by distinct, rather prominent radiating striæ, which, on the dorsal valve, nearly always increase by intercalation, and curved gradually outward, on the posterior lateral regions; while on the ventral valve they generally increase by bifurcation, and are nearly straight on all parts. A few distant, imbricating marks of growth are also usually seen around the free margins of adult examples; while well preserved specimens show minute, but not crowded, prominent, concentric lines crossing the much larger radiating striæ, and the furrows between them.

Length of a mature, rather gibbous specimen, 1 inch; breadth, 1.24 inches; convexity, 0.80 inch. Some examples are proportionally decidedly broader, and others a little less so." [Meek.]

Position and locality. Cincinnati Group; Richmond, Indiana; cabinet of Mrs. Mary P. Haines.

Orthis biforata, Schlotheim. Var. **acutilirata**, Conrad.

PLATE II, FIGURES 5, 6, 7, 8 AND 9.

Orthis acutilirata. Meek, 1873, Paleontology, of Ohio; Vol. 1, p. 119.

"The typical and most common form of this variety or species is much extended on the hinge line, which usually terminates in acutely angular, or even mucronated lateral extermities, thus causing the breadth to be sometimes twice or even in extreme cases, three times the length of the valves. Between these, however, and others having the hinge not more than one-fifth greater than the length, and only about equaling their greatest breadth, there is a completely uninterrupted series of intermediate forms. In all of its variations of proportional length and breadth, however, it agrees in having three, or very rarely four, simple, angular plications in the bottom of the sinus, and four, or very rarely five, on the mesial fold, which latter is always rounded, and but comparatively little elevated. All of its plications are simple, while they are smaller and more numerous than those of any of the other varieties found in this country; there being on each side of the mesial fold and sinus from 11 to 18, making the entire number about 26 to 40 on each valve. The specimens with the lateral extremities most extended have the largest number of plications, probably only because there is more space for them. In these, however, only about the same number reach the beaks as on those less dilated, as a number of the outer ones on the lateral extensions of those more produced laterally, run out on the hinge line without reaching the beaks.

This form becomes quite gibbous with age, the gibbosity being generally most obvious, (though not always actually greatest) in the specimens least extended on the hinge line, some of those with the most produced lateral extremities having the middle portions of the valve quite as convex as any of the others of the same anterio-posterior dimensions. In these the lateral slopes are very concave, and the anterior lateral margins sinuous and strongly converging toward the front. The mesial sinus is well defined, and widens and deepens rather rapidly forward: and as the mesial fold is proportionally less elevated, the front is often thus caused to be distinctly sinuous in the middle.

Old specimens become quite thickened within, and consequently have the cavity for the muscular attachments in the ventral valve very deep, and similar to that of the var. *lynx*. The surface granulations are usually very beautifully preserved on this variety.

In its much longer hinge line, more produced and acutely angular lateral extremities, more numerous and smaller plications, this form contrasts strongly with the variety *lynx:* while in these characters and its more depressed and rounded mesial fold, it is even much more strongly distinguished from all the other known kindred forms of this country.

In its great proportional breadth, and the small size and greater number of its plications, this shell would seem to agree more nearly with the typical European variety *bisulcata*, than any other we have in this country. Yet it differs in rarely ever having more than three (never more than four) plications in the sinus, instead of five to seven. (See McCoy's description of that form). It probably also differs in having its great lateral extension only at and near the hinge line, thus producing acutely angular lateral extremities, as this character is not mentioned in any of the descriptions of that variety I have seen. So far as I have yet observed, no form exactly corresponding to this has been figured from any foreign locality: and it is the most strongly marked type of the group yet known in this country.

I am much inclined to think it ought to be separated specifically from all the other forms here noticed under the general name *bisulcata*, not only on account of the differences mentioned, but because it is confined to one horizon: while all of the others, except the var. *lynx*, which has a much greater range, belong to lower horizons.

Length of a moderate sized, laterally extended specimen, 0.76 inch: breadth, 1.53 inches: convexity, 0.77 inch. Some examples are proportionally more extended on the hinge line, and others much less." [Meek.]

Position and locality: Cincinnati group; Richmond, Indiana; cabinet of Mrs. Mary P. Haines.

Genus RHYNCHONELLA. Fischer.

Rynchonella capax, Conrad.

PLATE I., FIGURES 9, 10 AND 11..

Rynchonella capax. Meek 1873, Paleontology of Ohio, p. 123.

"Shell attaining about a medium size, varying with age from compressed sub-trigonal to sub-globase, old examples being often more convex than their diameter in any other direction; posterior lateral margins somewhat straightened and converging to the beaks at about a right angle in young shells, but becoming more rounded in the adult; lateral margins rounding to the front, which is more or less distinctly sinuous, or nearly straight in the middle.

Dorsal valve generally a little more convex than the other, most prominent in the middle, and rounding abruptly, or sloping more gently, from the central regions in all directions; the more elevated part forming anteriorly a depressed mesial ridge that is nearly flat, and occupied by four plications on top, and rarely continues two-thirds of the way to the strongly incurved beak; while on young or compressed individuals, it is faintly marked even anteriorly; lateral slopes each occupied by four to seven or eight simple angular plications.

Ventral valve with its beak abruptly pointed, and very strongly incurved upon that of the other valve, in adult shells, but less distinctly curved, and showing a small opening under its apex, in young examples; mesial sinus deep and well-defined in gibbous specimens, and less so in the young or more compressed forms, never quite reaching the point of the beak, and always having three simple, rather angular plications in the bottom, that extend, like the others, to the apex of the beak, in well-preserved specimens; lateral slopes each occupied by from five to seven plications.

Entire surface of both valves marked by numerous, very regular, strongly zig-zag, prominent, sublaminar marks of growth, that become nearly or quite obsolete, sometimes, on old examples.

Length of a medium sized, moderately gibbous individual, 0.75 inch; breadth, 0.81 inch; convexity, 0.66 inch.

This species varies considerably in form, but generally increases regularly in convexity with age, some of the larger individuals becoming extremely gibbous.

It varies comparative little, however, in the number of plications, though the younger individuals usually show the marks of growth more distinctly than the largest and most convex ones. Large examples have the.

substance of the shell often much thicker within, on each side of the umbonal region of the ventral valve, with a deep angular impression between for the muscular scars, and a deep, narrowly rounded, rostral cavity, which makes the beak of this valve very thin, so that its apex is often broken away in such a manner as to appears as if there had been a perforation there. But many well preserved, adult specimens show that this is not the case, though there was always a small opening under the immediate apex, in young shells, which became closed, by the close incurving of the beak upon that of the other valve, with age. The hinge teeth of the ventral valve are quite prominent, and between these and the beak there is a concave space on each side of the rostral cavity, that sometimes presents the appearance of a very restricted concave area; but it seems to be the result of the truncation, as it were, of the thickened margin on each side of the rostral cavity, to form a space for the strongly incurved beak of the opposite valve. The cardinal process of the dorsal valve is moderately prominent, and so deeply divided as to present the appearance of two diverging teeth, with a slender, slightly raised ridge or line in the bottom of the division between; while a more or less defined mesial internal ridge extends forward nearly to the middle of the interior surface of the valve, and just outside of these divisions of the cardinal process, a deep pit is seen on each side, for the reception of the teeth of the other valve." [Meek].

Position and locality: Cincinnati Group; Richmond, Indiana; cabinet of Mrs. Mary P. Haines.

Rhynchonella dentata, Hall.

PLATE I., FIGURES 12, 13 AND 14.

Rhynchonella dentata, Meek. Paleontology of Ohio, Vol. I., p. 121.

"Shell rather small, trigonal-subglobose, generally slightly wider than long, and usually, in adult examples, quite convex; posterior lateral margins nearly straight, or a little convex in outline, and converging to the beaks at nearly a right angle; anterior lateral margins rounded or sub-angular; front usually a little sinuous, as seen in a direct view of either valve.

Dorsal valve more convex than the other, particularly in the anterior central region, where it is often very prominent, being elevated in the form of a distinct mesial ridge that is divided into two plications by a central furrow; lateral slopes rounding off more or less abruptly, and each occupied by from four to five simple, rather angular, radiating plications; beak strongly incurved.

Ventral valve (as seen in a side view) somewhat strongly arched from beak to front, or more or less compressed in the central region, and abruptly curved up at the front and beak; mesial sinus commencing small near the beak, and widening and deepening (with sloping sides and a single central plication) to the front, where it equals about one-half the entire breadth, and terminates a more or less produced sub-trigonal marginal projection, curved up nearly at right angles to the plane of the valve, and fitting into a corresponding sinus in the edge of the same; lateral slopes generally quite abrupt from the edge of the mesial sinus, and each occupied by about five simple sub-angular plications; beak incurved, but not so closely upon that of the other as to conceal the small foramen under its apex.

Surface of both valves with the plications continued to the points of the beaks, and imparting to the interlocking anterior margins a sharply zig-zag outline; while on well preserved specimens very fine, obscure lines of growth may be seen, by the aid of a magnifier, crossing the plications and furrows between them, parallel to the zig-zag anterior and lateral margins; though these lines are usually nearly or quite obsolete, excepting near the front.

Length of a rather large, well developed, gibbous specimen, 0.51 inch; breadth of same, 0.55 inch; convexity, 0.67 inch. Some individuals are proportionally more convex, and others less." [Meek.]

Position and locality: Cincinnati Group, Richmond, Ind.; cabinet of Mrs. Mary P. Haines.

LAMELLIBRANCHIATA.

Genus MEGAPTERA, Meek and Worthen.

A. Megaptera casei, Meek and Worthen.

PLATE I., FIGURES 1 AND 2.

Ambonychia (megaptera) casei, M. & W., Illinois Geological Report, Vol. III., p. 337.

"Shell trigonal, compressed sub-equivalve, extremely inequilateral, posterior side long, compressed and strongly alate; the wing very large, produced, pointed, and not separated from the alate posterior margin by a distinctly defined sinus; margin below the wing, sloping obliquely forward to the basal angle; cardinal margin the longest part of the shell, straight and much compressed from immediately behind the beaks. Anterior side truncated nearly vertically from the beaks, about half way down the front, thence sloping slightly backwards to the basal angle. Basal margin produced downwards, and terminating in a distinct angle, slightly in advance of the middle. Umbonal slopes very prominent, angular, or sometimes apparently bicarinate, straight, and extending from the beak, near the anterior margin, to the most prominent part of the base, ranging at an angle of about 65° below the horizon of the hinge-line, and provided with a longitudinal sulcus below the middle of the valves. Beak straight, rising a little above the cardinal margin, and quite terminal. Surface ornamented with distinct, irregular, alternately larger and smaller, thread-like radiating striæ, with less distinct concentric lines, and a few distinct, stronger marks of growth, which sometimes form promiminent, imbricating, sub-spinous projections on the umbonal angle.

Length, as inferred from the direction of the lines of growth, about 2 inches; hight, 1.73 inch; convexity, 0.64 inch." [Meek and Worthen.]

Position and locality: Cincinnati Group; Richmond, Indiana. The figures here given are copies of those of the type specimens in the private cabinet of Mr. L. B. Case, of Richmond, Indiana.

GASTEROPODA.

Genus CYCLONEMA. Hall.

Cyclonema bilix. Conrad.

PLATE II., FIGURES 3 AND 4.

Cyclonema bilix, Conrad. Meek, 1872, Paleontology of Ohio, Vol. I., p. 151.

"Shell vasing from rhombic sub-globose to conoid-subtrochiform; spire conical, but very variable in its elevation, thus causing considerable variation in the relative length and breadth of the entire shell, which, however, is most generally somewhat longer than the breadth; volutions four to five, increasing rather rapidly in size, compressed-convex, the compression being very variable in degree, and usually parallel to the general slope of the sides of the spire; last or body turn more or less narrowly rounded, or sometimes almost subangular below the middle; suture varying from merely linear to rather deeply channeled; aperture broad-ovoid to sub-quadrate; inner lip thickened, a little straightened and rather distinctly flattened, from near the middle downward; outer lip sharp and rather oblique. Surface ornamented by revolving lines and furrows, that vary greatly in size, arrangement and distinctness, and are crossed by fine, very oblique, regular, thread-like lines, and sometimes irregular ridges of growth; both of which, however, are subject, occasionally, to become nearly or quite obsolete.

Height of a medium sized specimen of typical form, 0.84 inch; breadth, 0.82 inch.

This is an exceedingly variable shell, so much so, indeed, that it is difficult, even after excluding some extreme forms that may be distinct species' to assign it definite characters. These variations consist not only of differences of general form, but also in the depth of the suture, the convexity of the volutions, and the out line of the aperture, as well as in the nature of the surface markings. The fine, regular, very oblique lines of growth, are most constant, but the revolving lines, ridges and furrows, are very variable in size and arrangement. All of these different varieties of form and surface markings, however, shade into each other by intermediate gradations, to such an extent that it seems hardly possible to separate them more than as varieties." [Meek.]

Position and locality: Cincinnati group; Richmond and Madison, Indiana; cabinet of Mrs Mary P. Haines.

CRUSTACEA.

(*Trilobites.*)

Genus CALYMENE, Brougniart.

Calymene senaria, Conrad.

PLATE II., FIGURES 1 AND 2.

Calymene Senaria. Meek, 1873, Paleontology of Ohio, Vol. I., p. 173.

"General form sub-ovate, the length being usually about one and a half to one and thre-fourths the breadth; convexity rather more than one-third the breadth.

Cephalic shield, as seen in a direct view from above, sub-semicircular, approaching sub-lunate, the anterior outline being more or less nearly regularly rounded, and the posterior broadly sinuous, with the posterior lateral extremities bluntly sub-angular, or abruptly rounded. Glabella more prominent than the cheeks or eyes, about as wide behind as its length, including the neck segment, very strongly defined from the cheeks and the front margin (which latter is very prominent, and strongly recurved and arched upward in the middle) by profound furrows; lateral lobes, particularly the posterior two pairs, distinctly defined by deep lateral furrows that curve a little backward, the posterior pair being transversely, or obliquely, a little oval, and about three times as large as those of the next pair, which are as much larger than the third pair, all being nearly round; neck furrow well defined; neck segment about the same size as the first thoracic segment, often slightly thickened at each end, arched a little forward, and nearly or quite as high as the most prominent part of the glabella in front. Eyes rather prominent, small, nearly surrounded, excepting on the inner side, by a shallow concavity, and situated opposite the furrows between the anterior and middle lateral lobes of the glabella; visual surfaces very small, about twice as long as high, a little arcuate, and directed nearly laterally; palpebral lobes small, rather prominent, and capping, as it were, the visual surfaces. Movable cheeks, with thick, rounded, lateral margins, defined by a distinct, rounded marginal furrow, continuous with that separating the anterior end of the glabella from the prominent, arched middle of the anterior margin. Fixed cheeks, provided with a very deep, broad furrow along their posterior margins. Facial sutures directed forward anteriorly, so as to intersect the margins somewhat nearer together than the breadth across between the eyes; posteriorly, sometimes slightly furrowed, and directed at first a little obliquely backward and outward from the eyes, for less than half their length, then curving somewhat abruptly, and extending more obliquely backward, nearly straight to, or very slightly in front of the posterior angles of the cheeks; rostral shield strongly arched, about twice and a half as long, measuring directly across from its lateral extremities, as the height from its upper to its lower margin, at the middle. Labrum or hypostome longitudinally oblong, with sinuous lateral margins; anterior end a little wider than any other part, with a convex outline; anterior margin prominent, rather deeply notched in the middle, with a projecting point on each isde of the notch. Internal surface concave; external, convex and smooth.

Thorax about twice the length of the middle of the cephalic shield, narrowing backward, and very strongly trilobate; mesial lobe as wide as the lateral, and distinctly more convex, rounded or somewhat depressed on top, and having its thirteen segments usually a little thickened at their ends, but without nodes. Lateral lobes separated from the middle one by distinct furrows, somewhat flattened on the inner third, and rounding off more or less strongly to the lateral margins; pleuræ extending straight outward for about one-fourth to one-third of their length, and then slightly deflected and curved backward to their outer ends, which are rounded, compressed, somewhat expanded, and provided with a thickened marginal ridge (not seen externally), while the anterior faces of their outer halves are strongly flattened or beveled for sliding upon each other in rolling up; each with its longitudinal furrow well defined, and placed so as to divide off, as it were, its anterior third, though this is not seen more than half way out from their inner ends, when the thorax is folded together.

Pygidium one-half to two-thirds the length of the middle of the cephalic shield, wider than long, with a more or less nearly sub-trigonal outline, the anterior margin, however, generally being so rounded as to impart a nearly transversly sub-oval form to the general outline; mesial lobe well defined, depressed convex, and extending very nearly to the posterior margin, showing five or six segments, the last two being very faintly defined, while behind those there is space enough for two or three more. Lateral lobes sloping off more or less rapidly, each with about five segments, only the anterior one of which has a furrow like that of each of the pleuræ. Entire surface finely and even granular.

Length of cephalic shield (at its middle), 0.52 inch; greatest breadth at the posterior angle of the cheeks, 1.08 inches; length of glabella, exclusive of neck segment, 0.34 inch; breadth of glabella, 0.32 inch. Length of thorax, about 1 inch; breadth at anterior, about 0.97 inch; breadth of anterior end of mesial lobe, 0.35 inch. Length of pygidium, 0.36 inch; breadth of the same, 0.50 inch.

This common and beautiful trilobite is regarded by many as only a variety of *Calymene blumenbachii,* Brongniart, which may be the case, as the characters in which it differs from that species are not very striking. Its most obvious differences consist in its more finely and evenly granulated surface, and smaller size; the *C. blumenbachii* having its surface marked by granulations, with tubercles, or larger granulations mingled with the smaller, and attains a rather decidedly larger size. There are also some other more or less important differences of details, such as the more produced and reflexed front margin of the head of *C. senaria,* the proportionally rather broader base of its glabella, and the more anterior position of its eyes.

Whether such differences should be regarded as being of specific, or only sub-specific importance, is, to some extent, a matter of taste, or perhaps more properly speaking, depends upon one's views in regard to the degrees, or kinds of differences, that should be considered specific. However this may be, it seems desirable, in the present state of our knowledge of these forms, to keep them separate." [Meek.]

Position and locality: Cincinnati Group; Madison, Indiana; cabinet of Prof. Collett.

UPPER SILURIAN.

ECHINODERMATA.

Genus EUCALYPTOCRINUS, Goldfuss.

Eucalyptocrinus crassus, Hall.

PLATE III., FIGURE 1.

Eucalyptocrinus crassus. Hall, twenty-eighth annual report of the Regents of University of New York, p. 141.

" Body massive, turbinate from the base to the arms, and with the interbrachial plates and arms attached, it has a general sub-ovate form with a truncate base, which in most specimens is deeply impressed at the column attachment. Basal plates small, concealed in the basal cavity. First radial plates much larger than the succeeding ones, height and width sub-equal; second radials quadrangular, length and breadth equal, the greatest width at the base; third radials hexagonal, the lower lateral and upper sides shorter than the other three. First supraradials somewhat smaller than the third radials, pentangular in well formed specimens; second supraradials less than half as large as the first, pentangular, supporting on each upper sloping side a small triangular plate, upon which rest the first arm plates. The inter-radial plates are one large and two smaller to each field; the large one is ten-sided and elongate-ovate, its greatest width above the middle; the others are nearly as long, but narrow, united at their margins the entire length, greatest width below the middle, the summits reaching as high as the fourth or fifth pair of arm plates. The inter-supraradial plate is single, having the form of the two upper interradials when united, but smaller.

This species is extremely variably in form and proportions of the body, the older specimens being often more elongate, and sometimes constricted near the middle of the cup, giving a concavity to the side. The base is much broader in some specimens, giving to the first radials a greater proportional breadth. It differs from the *E. lævis* and *E. phillipsi* of Troost, in the much greater height of cup, greater elongation of plates, and in having a less proportion of the first radial plates within the basal cavity." [Hall.]

Position and locality: Niagara group; near Waldron, Decatur county, Ind.

BRACHIOPODA.

Genus RHYNCHONELLA, Fischer.

Rhynchonella tennesseensis, Rœmer.

PLATE III., FIGURES 2, 3 AND 4.

Shell moderately large, often somewhat inflated or even sub-globose, sub-circular or sub-pentahedral in marginal outline, breadth and length about equal, and the thickness from one fifth to one quarter less. Ventral valve shallow, beak not prominent; median sinus broad, distinct in front, but disappearing in the umbonal region. Dorsal valve rather deep; median fold broad and distinguishable only at the front. Surface, besides the ordinary lines of growth, marked by about twenty obtusely angular radiating plications extending from beak to front on each valve; plications of nearly uniform size on all parts, except that they become somewhat smaller and less distinct upon the postero-lateral portions; about five of the plications occupy the median fold and sinus respectively.

Length and breadth each about 1.12 inches; thickness, 0.88 inch.

The shell described and figured by Dr. F. Rœmer is, in his Silurische Fauna von Westlichen Tennessee, is a much smaller one than that which is here figured, which latter shell is about the usual adult size as found in Indiana. The Indiana shells have usually been identified with Dr. Rœmer's species, but Prof. Hall thinks it doubtful whether that identification is correct, and he is more inclined to refer it to the *R. stricklandi* of Sowerby.

Position and locality: Niagara group; near Waldron, Decatur county, Ind.; cabinet of Prof. Collett.

Genus SPIRIFER, Sowerby.

Spirifer radiata, Sowerby.

PLATE III., FIGURES 5 AND 6.

Shell irregular sub-oval in marginal outline, broader than long, both valves moderately gibbous; hinge line shorter than the greatest width of the shell. Ventral valve having the umbonal region prominent and the beak distinct and incurved; cardinal area moderately broad-triangular; foramen rather small; median sinus narrow, extending from beak to front, readily distinguishable, but not sharply defined at its sides. Dorsal valve considerably shorter than the ventral, beak moderately prominent, median fold narrow and clearly distinguishable from beak to front, but not very sharply defined.

Surface marked by very numerous, fine, radiating lines, which are crossed by the ordinary lines of growth.

Length, 1.35 inches; breadth, 1.52 inches.

There seems to be no good reason to doubt the specific identity of this American shell with that to which the name was originally applied in Europe.

Position and locality: Niagara Group, near Waldron, Indiana; cabinet of Prof. Collett.

GASTEROPODA.

Genus PLATYOSTOMA, Conrad.

Platyostoma niagarense, Hall.

PLATE III., FIGURES 7 AND 8.

Platyostoma niagarense, Hall, 28th An. Rep. Regents Univ., N. Y., p. 175.

" Shell ovoid or sub-globose, volutions three to four, the last one very ventricose, spire varying from the plane of the outer volution to an elevation of one-fifth or one-fourth the height of the shell above.

Apex minute, somewhat rapidly expanding, the first two volutions usually symmetrical; the outer volution often unsymmetrical, very ventricose and regularly rounded upon the back, but not unfrequently extended and becoming free toward the aperture, and marked on the upper or lower side, or upon both, by a groove, along which the striæ are abruptly bent, indicating a sinus in the peristome during some period of its growth; peristome entire or undulated, sometimes distinctly notched in the margin, free or adhering on the columellar side, and sometimes expanded and presenting a thickened callosity or columellar lip.

Surface marked by fine undulating striæ of growth, which sometimes become lamellose. In well-preserved specimens finer revolving striæ cancellate the striæ of growth, and sometimes the surface is marked by revolving ridges." [Hall.]

Position and locality: Niagara Group, near Waldron, Decatur county, Indiana.

CRUSTACEA.

(*Trilobites.*)

Genus CYPHASPIS, Burmeister.

Cyphaspis christyi, Hall.

PLATE III., FIGURE 9.

Cyphaspis christyi. Hall, 28th An. Rep. Regents Univ. N. Y., p. 188.

"General form of body elongate-oval, the length nearly twice the greatest width of the thorax.

Head semi-oval, the posterior margin slightly concave, highly elevated in the middle, bounded by a proportionally strong, thickened rim, the posterior angles being prolonged into slender spines reaching to the sixth or seventh thoracic segment, and slightly divergent. Glabella small, broad-oval, rounded in front and truncate behind, about half the length of the head, greatest width anterior to the middle; surface convex, very prominent behind, some specimens showing faint indications of a pair of short oblique furrows anterior to the middle; near the base on each side a small ovate node separated from the glabella by a distinct furrow; longitudinal furrows moderately deep. Eyes small, very prominent and rounded, situated about one-third the length of the head from the posterior margin; distance from center to center equal to the length of the head forward of the occipital furrow; the surface smooth. Occipital ring narrow, the furrow well marked, becoming less distinct toward the posterior cheek furrows. Cheeks not prominent except anteriorly.

Thorax with twelve segments, highly convex, deeply lobed, lobes nearly equal in the anterior portion; the axial lobe more rapidly tapering posteriorly than the lateral ones, its annulations curved forward in the middle; later segments curved a little backward, the extremities obtusely rounded, somewhat abruptly bent a little nearer the axial extremities, causing an angular ridge along each lateral lobe; each segment marked by a strong longitudinal furrow nearer the anterior margin.

Pygidium small, sub-semicircular, a little arched forward on the anterior border; axial lobe extending a little more than two-thirds the length of the pygidium, rounded at the extremity and marked by one distinct and one indistinct annulation, as also in the lateral lobes. Surface marked by small scattered pustules, most distinct on the cheeks and segments of the axial lobe." [Hall.]

Position and locality: Niagara Group; near Waldron, Decatur county Indiana.

DEVONIAN.

POLYPI.

Genus ZAPHRENTIS, Rafinesque and Clifford.

Zaphrentis, ——?

PLATE V., FIGURES 3 AND 4.

Genus FAVOSITES, Lamarck.

Favosites, ——?

PLATE V., FIGURES 1 AND 2.

These two corals are figured on plate V. as being in a general way, at least, characteristic of the Devonian rocks of Indiana.

Both species occur among many other coralline forms in the Devonian rocks near Jeffersonville, Indiana, where they were collected by Mr. V. W. Lyon of that place. They are not described nor even specifically indentified in this article, because of the great necessity that is recognized of a thorough revision of the fossil corals of our country, and the consequent doubt that is naturally felt as to the correctness of specific determinations by means of merely the external features. External characteristics, it is true, will always remain valuable aids in the specific determination of fossil corals, but in the present state of paleontological science one is not justified in omitting microscopic and other details of internal structure.

BRACHIOPODA.

Genus STROPHODONTA, Hall.

Strophodonta demissa, Conrad.

PLATE IV., FIGURES 6 AND 7.

Strophodonta demissa, Hall, Paleontology N. Y., Vol. IV., p. 101.

"Shell semi-elliptical, usually wider than high, length and breadth often nearly equal; hinge line equaling or greater or less than the width of the shell below, abruptly contracted beneath the extremities, which are often auriculate; in some specimens the sides are nearly straight, and parallel for more than half the length of the shell.

Ventral valve regularly convex, often gibbous; greatest elevation nearly central, and sometimes sub-angulated along the middle; umbo small and prominent, with the apex slightly incurved and extending beyond the plane of the area; surface a little concave toward the cardinal angles, which are slightly deflected. Dorsal valve moderately concave, rarely following the convexity of the opposite valve; sometimes an undefined median depression extends from beneath the apex to the front of the shell.

Area of the ventral valve variable, usually of moderate width, from 8-100 to 12-100 of an inch wide in the center, having a low triangular outline, concave in the middle, and for a considerable distance on each side of the beak strongly striated transversely, and more faintly longitudinally, sometimes marked along the middle by a sub-angular elevation; inner margin crenulated for nearly its entire length. There is no foramen, but sometimes a smooth triangular space beneath the beak. Dorsal area narrow and usually linear, sometimes wider and sometimes narrower in the middle, and the margin for a short space free from crenulations. The planes of the two areas are inclined so as sometimes to give less than a right angle between them, but generally a greater angle, and along the middle the two are often nearly in the same plane.

Surface marked by numerous crowded striæ, about nine or ten of which are much stronger and more elevated on the umbo of the ventral valve, with finer ones coming in between and on either side; striæ frequently increasing by intercalation and bifurcation, until they become very numerous and much finer at the margin. On the dorsal valve the striæ are similar to those of the ventral valve. In well-preserved specimens fine concentric striæ cover the entire surface, but the greater number of specimens do not preserve these markings. The coarser striæ are sometimes seen separated in the middle of the shell, each one presenting the appearance of a fascicle of striæ, which spreading, cover the lower part of the shell with extremely fine crowded striæ.

The interior of the ventral valve, and casts of the same, show a large flabelliform divaricator muscular impression, which is somewhat widely separated in front, and each division distinctly lobed. The occlusor muscular impressions occupy a semi-elliptical space on each side of a narrow central depression, the marking on either side being double in well preserved specimens. The upper extremities of this impression are close under the arch of the umbo, and separated by a smooth space from the divaricator impressions.

Beyond the muscular impressions, the interior surface is minutely pustulose, the points being more prominent just without their limits; beyond which, the course of the vascular impressions can be distinctly traced. In the dorsal valve, the anterior and posterior occlusor muscular impressions are very conspicuous and deeply marked, and often limited by an elevated ridge, a narrow longitudinal ridge dividing the two pairs. On each side, and below the muscular impressions, the surface is marked by small pustules or tubercles; and beyond these the surface is minutely pustulose, the vascular impressions becoming distinct towards the margin. The cardinal process is divided from the base, the divisions strongly diverging." [Hall.]

Position and locality: Hamilton Group, Charleston, Indiana.

Genus ORTHIS, Dalman.

Orthis iowensis. Hall (?).

PLATE V., FIGURES 10, 11 and 12.

Orthis iowensis. Hall, Geology of Iowa, Vol. I., Part ii., p. 488.

"Shell resupinate, transversely oval or sub-globose, with a deep sinus in front; hinge line less than two-thirds the greatest width of the shell. Ventral valve much the less convex, greatest convexity near the beak, and flattened towards the margins, with a deep sinus from the middle to the base of the valve; beak elevated slightly above the opposite, pointed, not incurved. Dorsal valve extremely gibbous, greatest convexity about the center of the valve, and sloping abruptly to the sides; umbo arched; beak prominent, slightly incurved over, and projecting beyond the hinge line. Area small; foramen narrow.

Surface marked by fine, closely arranged, radiating, tubular striæ, which increase by bifurcation and interstitial addition, and are crossed by fine concentric striæ and a few imbricating lines of growth; radiating striæ presenting numerous tubular openings upon the surface, and marked by fine pores or punctæ over the entire surface. Interior of ventral valve marked by strong muscular impressions, which are limited by dental lamellæ and divided in the center by a strong ridge, presenting a quadrangular area below the hinge line, the vascular impression proceeding in radiating impressed lines from the base of this quadrangular area; teeth strong, prominent. Dorsal valve deeply concave, with strong prominent brachial processes, and a median cardinal process, which is sometimes bilobate. Entire interior of shell punctate; striæ marking the inner margins of both valves, but rarely extending far beyond." [Hall.]

The specimen figured on Plate V., although presenting some differences from the typical forms of *Orthis iowensis*, is probably identical with that species. I have seen examples from the same locality at which the types of that species were obtained which have quite as deep a sinus in the front of the ventral valve as this example has. I am, however, not without some doubt as to its identity with *O. iowensis*, especially as there are several other recognized species from the same, or nearly the same, geological horizon in different parts of the country which are at least closely related to it. It may thus be compared with *O. tulliensis*, *O. propinqua*, *O. impressa*, etc.

Position and locality: Devonian strata, Charleston, Ind.; cabinet of Mr. Geo. K. Greene.

Genus ATRYPA, Dalman.

Atrypa reticularis, Linnæus.

PLATE V., FIGURES 7, 8 AND 9.

This species is so characteristic of the genus, and of the Devonian rocks so almost world-wide in its distribution, and withal so well known, that it is not thought necessary to rediscribe it here. The specimen figured on plate V. is from Charleston, Indiana, Cabinet of Prof. Collett.

Genus ATHYRIS, McCoy.

Athyris vittata, Hall.

PLATE IV., FIGURES 8 AND 9.

Athyris vittata, Hall, Paleontology of N. Y., Vol. IV., p. 289.

"Shell ovate-subquadrate, gibbous, with the mesial fold and sinus distinct; front conspicuously sinuate; hinge-line short; cardinal extremities rounded.

Ventral valve gibbous above, more convex than the dorsal; umbo prominent; the beak incurved and truncated in the plane of the longitudinal axis by a round foramen, curving very abruptly to the cardinal and cardinolateral margins; the center marked by a well defined mesial sinus, which is continued nearly or quite to the beak, and becoming much deeper and subangularly margined towards the front.

Dorsal valve a little less gibbous than the ventral valve, sides regularly curving; the middle of the upper part distinctly prominent, and developed below in a strong mesial fold which is abruptly elevated in front.

Surface marked by regularly imbricating lamellose lines of growth, which, on the better preserved surfaces, are finely crenulate on their edges, and the intermediate spaces striate." [Hall].

Position and locality: Devonian strata at Charleston, Clarke county, Indiana; cabinet of Prof. Collett.

Genus SPIRIFER, Sowerby.

Spirifer acuminata, Conrad.

PLATE IV., FIGURES 1, 2 AND 3.

Spirifer acuminata. Hall, Paleontology of New York, Vol. IV., p. 198.

"Shell large, ventricose, transverse, with the hinge line usually less than the width of the shell; cardinal extremities rounded or truncated, having a sub-elliptical or sub-quadrate outline, mesial fold and sinus extreme. Surface plicated. Ventral valve variably convex on the two sides, with a wide mesial sinus, which is well defined in the upper part, becomes wider and deeper and less distinctly defined in the middle of the shell, and is produced in front into a long triangular extension; gently or more abruptly curving from the greatest convexity to the sides and cardinal angles; umbo prominent, with the apex incurved over the wide, triangular fissure; area extending to the cardinal angles, with the margin rounded, except toward the extremities.

Dorsal valve gibbous, highly elevated in the middle into a strong angular mesial fold, and curving from the sides of the fold to the margin of the shell, except at the cardinal angles, where it is a little flattened and projecting, so as to give a minute auriculate appearance; summit of the mesial fold regularly arcuate from beak to base; apex slightly incurved over the narrow, nearly vertical area.

Surface, on either side of the mesial fold and sinus, marked by from sixteen to twenty plications, about four or five of which, nearest the center, are dichotomous from below the middle of their length; ribs low and rounded above, flattened below the middle, those towards the margin very slender; the first ten or twelve ribs on each side occupy the greater part of the valve. The entire surface is marked by delicate concentric striæ, which are often crowded into imbricating lamellose lines towards the front of the shell. In very perfect specimens these concentric striæ are papillose or fimbriated by fine radiating striæ. These fine surface markings, however, are usually nearly or quite obliterated." [Hall.]

Position and locality: Devonian strata; North Vernon, Indiana; cabinet of Professor Collett.

Spirifer euritines, Owen.

PLATE IV., FIGURES 4 AND 5.

Spirifer euritines. Owen, Geol. Sur. Wisconsin, Iowa and Missouri, p. 586.

"Shell nearly semi-elliptical, cardinal area very wide, slightly concave and fully striated; narrow perforation; beaks sometimes more than half an inch apart; smooth, with eighteen to twenty ribs on either side of the bourrelet, finely striated longitudinally, sometimes studded with small granulæ; bourrelet rather narrow, with a shallow sinus in the median line, finely striated and crossed by fine concenteric lines of growth, and sometimes by fine granulæ. Sinus of the dorsal (ventral) valve also sometimes finely granulated.

Length, one inch; breadth, one and a half inches." [Owen.]

Position and locality: Devonian strata; Charleston, Indiana; cabinet of Mr. George K. Greene.

Spirifer gregaria, Clapp.

PLATE IV., FIGURES 10 AND 11.

Spirifer gregaria. Hall, Pal. N. Y., Vol. IV., p. 195.

"Shell ventricose, sub-globose, semi-oval or sub-quadrate in outline; hinge line equaling or less than the width of the shell; cardinal extremities truncate or rounded. Surface plicated.

Ventral valve the more gibbous, regularly arcuate from beak to front, the greatest convexity at or a little above the middle, and curving somewhat abruptly to the sides and more gently to the front; beak much elevated, and the apex closely incurved over the fissure; area high, concave, and extending to the cardinal angles, where it is sometimes more than half a line high, often distinctly striated; mesial sinus rounded or sub-angular, and much produced in front.

Dorsal valve very convex, with a strong mesial fold, either angular orr somewhat flattened along the summit, and sometimes marked by an indistinct groove; beak often considerably elevated and slightly inclined over the hinge line; area narrow except in the center, where it perceptibly widens.

Surface marked by fr[illegible] six to ten strong rounded ribs on each side of the mesial fold and sinus; the entire surface with undulating concentric striæ, which, towards the front, become strong zig-zag imbricating lines.

The interior of the ventral valve presents a well defined oval muscular impression with a low crest in the center. The dental plates are often much thickened, filling the entire rostral cavity and encroaching upon the muscular area.

The width of the species ranges from one-half to seven-eighths of an inch, and the length is sometimes a little greater but usually a little less than the width. In the more gibbous specimens, the beak of the ventral valve is so extremely elevated that one half of the length of the valve is above the cardinal line. In the majority of specimens, there are about six or seven plications on each side of the valve. The variable gibbosity of the shell gives an apparent variation in the height of the area, the beaks of the two valves sometimes approaching close to each other." [Hall.]

Position and locality: Various localities in Indiana and adjoining States; Devonian strata of the age of the Hamilton group; cabinet of Mr. Geo. K. Greene.

LAMELLIBRANCHIATA.

Genus PARACYCLAS, Hall.

Paracyclas elliptica var. occidentalis, Hall.

PLATE V., FIGURES 5 AND 6.

Lucina (*Paracyclas*) *elliptica var. occidentals.* Hall, 24th An. Rep. Regents Univ., N. Y., p. 189.

"Shell orbicular, of medium size, nearly circular in outline, with regularly convex valves and small, closely appressed and approximate beaks, centrally situated. Cardinal border very slightly excavated just anterior to the beaks, but rounded and full behind. The sinus just within the posterior cardinal margin (so characteristic of the group), is but slightly developed. Surface marked by strong, sharp striæ, which are often developed into irregular concentric ridges." [Hall.]

The specimen figured on plate V. is an unusually large and fine one, from the cabinet of Dr. James Knapp, of Louisville, Kentucky, who also furnished Prof. Hall with his type specimens of this variety.

Position and locality: Hydraulic limestone; Centreville, Indiana.

SUB-CARBONIFEROUS.

POLYPI.

Genus LITHOSTROTION, Fleming.

Lithostrotion mamillare, Castelnau.

(Lithostrotion canadense, Castelnau.)

PLATE VI., FIGURES 1 AND 2.

Corallum massive, or sometimes occurring in dendriform tufts, varying in these respects with the greater or less compactness of contact of the corallites, but they are usually all in close contact with each other, as shown in figures 1 and 2; calyces circular if the corallites are free, but polygonal if they are in contact with each other, very unequal in size, deep, the bottom elevated, and its center usually bearing a salient columella, which is sometimes laterally compressed to a slight degree; two very small septal fossets are usually discernable in well-preserved examples, one on each side of the columella, in the direction of its longitudinal axis, one of them being a little deeper than the other. The number of rays varying with the size of the corallite; from 18 to 44.

This is one of the most widely distributed and characteristic fossils of the Sub-carboniferous rocks of the interior States, ranging from northern Iowa to Alabama, marking characteristically the horizon of the St. Louis division of the Sub-carboniferous series.

The specimen figured on plate VI. is from Monroe county, Indiana, which is part of the same specimen containing three or four double corallites, and figured on plate 40. Annual Rep. U. S. Geol. Sur. Terr., 1878.

ECHINODERMATA.

Genus TAXOCRINUS, Phillips.

Taxocrinus multibrachiatus, Lyon and Cassady. **Var. colletti, White.**

PLATE VII., FIGURE 3.

Body having the usual sub-globose form common to the genus, the separate pieces being slightly convex and showing slight if any tendency to become angular along the median line of the rays and their subdivisions; underbasal pieces not observed, being covered by the column; basals (sub-radials) projecting considerably beyond the surface of the column, one of them being much larger than the others, projecting up into the oval area and somewhat widely separating the first radial pieces of the two posterior rays; primary radial pieces, five to the anterior ray and four to all the others; the upper border of the upper primary ray bearing a short median projection the piece being somewhat broader than the others, but otherwise of similar size; upper border of all but the upper piece of each primary ray concave, as seen at the sutures, where small petaloid pieces are sometimes present; pieces of the secondary rays, four for the two of the anterior primary ray and three for all the others (except in case of one secondary ray, there are four); petaloid pieces being usually present at their sutures; tertiary rays composed of from seven to nine pieces, their sutures being straight or only slightly sinuous; each tertiary ray is divided into two arms, and each alternate arm is dichotomous.

Anal series not fully observed, but it occupies a considerable space, a little larger than the corresponding interradial spaces, and the anal opening seems to have been a little eccentric; primary interradial spaces of moderate size, occupied by six or seven principal pieces, with other minute pieces above them; one or two minute pieces exist between each pair of secondary rays, but beyond these no interradial pieces, as a tertiary series are visible. Whole surface granular. Column round, composed of uniform thin joints.

This form agrees with the description of *Forbesoocrins multibrachiatus*, Lyon and Cassady, as published by them in Am. Jour. Sci. and Arts, Vol. XXVIII., p. 235, but it differs in having five primary pieces to the anterior ray instead of only four; in having only one or two minute secondary interradial pieces to each ray, instead of six or seven, and in having no third series of interradial pieces. These differences would by many be regarded as fully of specific importance, and perhaps they are really so; but in view of the wide variation that is now known to exist among crinoids within specific limits, it is thought best to regard the form represented by our example as only a variety of *Taxocrinus multibrachiatus*, L. and C. I refer to these forms to *Taxocrinus* in accordance with the views expressed by Wachsumth and Springer in their excellent Revision of the Paleocrinidæ.

Position and locality: Keokuk division of the sub-carboniferous series; Crawfordsville, Ind.; cabinet of Prof. Collett, in whose honor the variety name was given.

Genus SCAPHIOCRINUS, Hall.

Scaphiocrinus gibsoni*, White.

PLATE VII., FIGURE. 7.

Scaphiocrinus gibsoni. White, Proc. Acad. Nat. Sci., Phila., 1878, p. 31.
Scaphiocrinus gibsoni. White An. Rep. U. S. Geol. Sur. Terr. for 1878, p. 161.

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* The specific name is given in honor of Mr. Wm. Gibson, of Newport.

"Body small, or not above medium size for a species of this genus; calyx roughly cup-shaped, the pieces composing it moderately thick and protuberant, especially the first radial, sub-radial and first anal pieces; base small, nearly or quite covered by the first joint of the column; sub-radial pieces comparatively large, tumid; first radial pieces broader, but scarcely larger than the sub-radials; sutures between the pieces of the calyx impressed, especially at the points where the angles meet, and where there are pit-like depressions which increase the tumid appearance of the pieces and give the calyx a somewhat shrivelled aspect; anal space comparatively large. The postero-lateral rays consist of three pieces, including the first radials, and upon each of the third radials the first bifurcation of the ray takes place; and above this the posterior secondary division of the ray only bifurcates; this third bifurcation taking place on the eighth piece above the second bifurcation, giving five simple arms for each of the postero-lateral rays beyond all the bifurcations. All the pieces composing the rays, including those of both the primary and subordinate divisions, have a tendency to become angular upon the back, especially at the upper side of each.

This, together with the apparent corrugation of the calyx and the zigzag articulation of the joints of the arms near the upper ends, gives the whole specimen a good degree of asperity of aspect. Pinnules strong and somewhat angular, arising alternately one from each joint of the arms and subordinate divisions of the rays. The other rays are not fully known, but they apparently bifurcate in nearly the same manner as the postero-lateral ones. Column moderately large, composed of irregularly alternating larger and smaller pieces. The whole surface of body, arms and column, minutely and distinctly granular, as seen under the lens.

This species resembles *S. æqualis* (Hall), as figured by Meek and Worthen in Vol. V., Geological Report of Illinois, more nearly than any other form known to me, but it differs from that species in the much greater proportionate length of the arms, as well as their number and the manner of their bifurcation, besides the difference in the character of the surface. A conspicuous difference is also seen in the divisions of the rays, *S. æqualis* having eight arms by the ultimate division of each postero-lateral ray, while *S. gibsoni* has only five. In the former species also the joints of the upper parts of the arms lack that zigzag arrangement which they have in the latter, and the general asperity of aspect of the latter is wanting in the former.

Position and locality: Sub-carboniferous strata, Keokuk division, Crawfordsville, Indiana; cabinet of Mr. William Gurley.

Scaphiocrinus gurleyi. White.

PLATE VII., FIGURE 8.

Scaphiocrinus gurleyi. White, Proc. Acad. Nat. Sci., Philad., 1878, p. 32. An. Rep. U. S. Geol. Sur. Terr. for 1878, p. 162.

Body of medium size or somewhat less; calyx roughly cup-shaped; sub-radial, first anal and first radial pieces prominent, the sutures being deeply impressed; base nearly covered by the last joint of the column; sub-radial and first anal pieces as large as, or a little larger than, the first radials; the anterior and the two antero-lateral rays only are known. These rays consist of three pieces each, including the first radials already mentioned as constituting a part of the calyx, and upon the third radial the first bifurcation of the ray takes place, each division being once more bifurcated at varying distances from the first. In the anterior ray the second bifurcation takes place upon the eleventh piece from the first. In the antero-lateral rays the second bifurcation takes place upon the ninth piece of the anterior branch of each of those rays above the first bifurcation; and upon the seventh piece, in the case of the posterior branches of the same respectively. Near the tips of some of the arms there is still another bifurcation, the divisions of which, being very small, may be easily overlooked, or confounded with the coarse pinnules. The pinnules are large, long, angular and alternately arranged upon each side of the arms, each piece of all the divisions of the arms above the first bifurcation of the rays bearing only one. The backs of all the divisions of the rays are rounded, and have little or no tendency to become angular, except, perhaps, towards the extremities of the arms. Column composed of irregularly alternately larger and smaller pieces. Surface finely granular.

The calyx of this species closely resembles that of *S. gibsoni*, especially in the tumidity of the sub-radial and first anal pieces, and in the character of the column; but it differs conspicuously from it in the number of arms and the character of their bifurcations, as well as in the surface markings and other details.

Position and locality: Keokuk division of the Sub-carboniferous series; Crawfordsville, Indiana;* cabinet of Mr. Wm. Gurley, in whose honor the specific name is given.

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*In the original description of this species the locality was inadvertently given as in Illinois instead of Indiana.

Genus ACTINOCRINUS, Miller.

Actinocrinus wachsmuthi, White.

PLATE VII., FIGURE 6.

Actinocrinus wachsmuthi. White, An. Rep. U. S. Geol. Sur. Terr. for 1878, p. 162.

Body rudely sub-turbinate below the arms, the sides expanding gradually and with slight convexity up to near the arm-bases, where there is a more abrupt expansion; base broader than high, rather deeply notched at the sutures by the prominence of the middle portion of each basal piece; column-facet large; first radial pieces nearly equal in size with the basals, and with that exception they are the largest pieces in the body; second and third radials about equal to each other in size and not more than half as large as the first radials, each third radial piece bearing two secondary rays consisting of two pieces each, both of which are smaller than the second and third radials, each second secondary radial piece bearing two brachial pieces, and each first brachial piece giving origin to an arm, making twenty arms in all.* Arm long and slender, and above the first four or five brachial pieces, which are single, they are composed of a double series of minute pieces which meet at a not very deeply zig-zag suture along the median line of the arm. Anal-pieces eight or nine, the first one being of about the same size as the first radials; the next three pieces above are about half as large as the first, and above these the other pieces are quite small; interradial pieces three or four, the first one being somewhat larger than the second radials and occupying about half of the whole interradial space.

Vault convex or sub-conical, more than half as high as the body below the arms, composed of irregular pieces of moderate size, all of which are more or less sharply tumid in the middle; vault ending at the summit in a long, strong proboscis which is composed of sharply tumid pieces similar to those of the vault. All the body plates are strongly tumid, the lower ones bearing each a strong transverse projection.

Position and locality: Keokuk division of Sub-carboniferous series; Crawfordsville, Indiana; cabinet of Mr. Wm. Gurley.

Figure 6, Plate VII., represents one of the type-specimens of this species, having the arms and stem removed. The specimen showing a part of the arms and the proboscis is figured in Annual Report of the U. S. Geological Survey of the Territories already cited.

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*The example figured on plate VII. has an extra arm-base immediately over the center of the anal space; and it also has an extra basal piece, which is about one-third as large as each of the other three basal pieces.

Genus PENTREMITES, Say.

Pentremites pyriformis. Say.

PLATE VII., FIGURE 9.

Pentremites pyriformis. Hall, Geology of Iowa, Vol. I., part II., p. 693.

"Body pyriform, the greatest diameter in the middle, and tapering to both extremities; the summit more obtuse and rounded, obtusely pentangular below the pseudambulacral areas, with sides flat; base narrow, with the upper joint of the column usually remaining attached. Basal plates forming a pentagonal shallow vase. Radial plates spreading and ascending, angular, along the middle at the base, deeply furcate, slightly concave along the lateral sutures. Interradial plates narrow-lanceolate, reaching nearly to the summit. Pseudambulacral areas lanceolate, gradually enlarging from the base, concave toward the median line, or sometimes flat; the number of pore-pieces varies from thirty to fifty on each side of the median line. Mouth pentagonal; ovarian apertures closely arranged, often somewhat transversely oval." [Hall.]

This is one of the longest and best known species of this genus; and is widely distributed in the Chester division of the Sub-carboniferous series.

Position and locality: Chester or Kaskaskia division of the Sub-carboniferous series; Down Hill, Crawford county, Indiana; cabinet of Professor Collett.

Pentremites godoni, DeFrance.

PLATE VII., FIGURES 10 AND 11.

Pentremites godoni. Hall, Geology of Iowa, Vol. I., part II., p. 692.

"Body ovoid, short, sub-truncate below, obtusely pentangular-stelliform in outline; basal plates forming a small pentagonal moderately convex disc, with the spreading upper joint of the column usually attached, and presenting a small papilliform elevation; radial plates extending almost rectangularly to the base of the pseudambulacral areas, abruptly bent and obtusely angular in the middle of the base; sides nearly parallel, deeply forked for the reception of the pseudambulacral areas; interradial plates long-lanceolate not reaching to the summit; pseudambulacral areas, long-lanceolate, reaching nearly to the base of the calyx, very gradually widening above, convex, each side curving to a median suture which is more elevated than the sides; poral plates narrow, crowded, from forty to fifty on each side, nearly rectangular to the area, and slightly curving upward on the median line. Mouth pentangular; ovarian apertures broad oval; summit convex." [Hall.]

Position and locality: Chester division of the Sub-carboniferous series, Dubois, Harrison and Crawford counties, Indiana.

Pentremites conoideus, Hall.

PLATE VII., FIGURE 12.

Pentremites conoideus, Hall, Geology of Iowa, Vol. I., part II., p. 655.

"General form conoidal or pyramidal, with the angles rounded; base sub-truncate; apex a little flattened. Basal plates slightly convex; radial plates extremely elongated and deeply divided for the reception of the pseudambulacral areas; interradial plates deeply inserted between the radial plates, long lanceolate and very acutely pointed above; pseudambulacral spaces very elongate, narrow, extending nearly to the base, with sides sub-parallel, convex along the median line, which is sharply depressed; poral plates varying with age from twenty-five to fifty; ovarian apertures circular; anal aperture ovate and much larger than the others. Surface marked by fine closely arranged striæ which, on the radial plates, are parallel to the margins till near the summit, where they are stronger and diverge from the suture; striæ on the interradial plates diverging from the center. Length, from one-fourth, to three-fourths of an inch." [Hall.]

Position and locality: Warsaw division of the Sub-carboniferous series; Spurgen Hill, Bloomington and other places in Indiana; cabinet of Prof. Collett.

BRACHIOPODA.

Geuns SPIRIFER, Sowerby.

Spirifer textus, Hall.

PLATE VII., FIGURES 1 AND 2.

Spirifer textus. Hall, Tenth An. Rep. Regents Univ., N. Y., p. 169.

"Shell large, somewhat thin, semi-circular or sub-semicircular, one-third to one-half as long as broad; height often greater than length; hinge equaling the greatest width of the shell and terminating in more or less salient angles at the extremeties; dorsal valve convex, most prominent near the front, rising in the middle into a rounded mesial fold, which diminishes regularly and somewhat rapidly from the front; beak, together with the narrow area, distinctly arched; ventral valve much more convex, very prominent at the umbo, from which it slopes at an angle of about 100° towards the lateral margins and more abruptly to the front; mesial sinus deep, rapidly increasing from beak to front, where it occupies about one-fourth of the anterior margin, terminating in a broad projection with a rounded extremity; beak angular, far removed from the hinge by the high intervening area, nearly straight or slightly arched towards the extremity; area very large and high, plain below; foramen large, triangular, about two-thirds as broad as high. Surface marked by about twenty simple depressed and rounded plications on each side of the mesial fold and sinus; plications crossed by fine, irregular undulating concentric lines of growth. Entire surface delicately and beautifully marked by minute elongated pits, so disposed as to present, under a magnifier, the appearance of twilled cloth." [Hall.]

Position and locality: Knobstone division of the Sub-carboniferous series, near Providence and New Albany, Indiana; cabinet of George K. Greene and Professor Collett.

PTEROPODA.

Genus CONULARIA, Miller.

Conularia missouriensis, Swallow. ?

PLATE VI., FIGURE 4.

Conularia missouriensis. Meek & Worthen, Vol. IV., Ills. Geol. Rep., p. 541.

"Shell attaining a large size, presenting the usual elongated, four-sided, pyramidal form, two of the opposite sides being wider than the others, with their lateral margins diverging towards the aperture at an angle of about eighteen degrees, while those of the narrower sides diverge at an angle of about twelve or fifteen degrees; transverse section (in a distorted specimen) rhombic; angles at the four corners rather deeply furrowed; sides without a distinct mesial furrow. Surface marked by comparatively strong, rather prominent, apparently smooth, sharp, transverse costæ, about half as wide as the rounded furrows between; in passing across the sides these curve more or less upward towards the aperture, and are often interrupted and alternating in the middle; costæ and spaces between, so far as can be seen, without crenulations.

Length of a specimen incomplete at both extremities, 6.10 inches; breadth of one of the wider sides at smaller end, 0.52 inch; breadth of same at larger end, 1.88 inches; breadth of narrow sides at smaller end, about 0.50 inch; breadth of same at larger end, about 1.30 inches." [Meek & Worthen.]

This specimen, represented on plate VI., is identified somewhat satisfactorily with the *C. missouriensis* of Swallow, as figured and described by Meek & Worthen. The shape and surface markings agree well, and as ours is plainly a broken specimen, its full size may have been quite equal to that of the Illinois specimens, which were upward of six inches in length.

Position and locality: St. Louis division of the Sub-carboniferous series Ellettsville, Ind.; cabinet of Prof. Collett.

GASTEROPODA.

Genus PLATYCERAS, Conrad.

Platyceras equilatera, Hall.

PLATE VII., FIGURE 5.

Platyceras equilatera. M. & W., Ill. Geol. Rep., Vol. V., p. 518.

"Shell attaining a medium size, composed of about one to one and a half turns; apex small, laterally compressed, and closely incurved, nearly on the same plane as the general curve of the body of the shell, or but very slightly oblique; body portion merely arched, and rapidly and nearly equally expanding to the aperture, which has an irregular, sub-circular, or broad sub-oval outline; lip rather sharp, and more or less sinuous, sometimes distinctly so. Surface with undulating lines, and near the margins of the lip stronger sub-imbricating marks of growth; the undulations in the markings corresponding to the sinuosities of the lip, which sometimes produce traces of obscure longitudinal folds near the aperture.

Greatest length of a mature specimen, measuring from the anterior margins of the lip to the most prominent part of the arch of the spire, 1.62 inches; breadth of the aperture, 1.15 inches.

Like many other species of this genus, this shell varied considerably at different stages of growth, the young shells being nearly smooth, while in adults the undulating marks of growth are strongly defined near the lip, which often becomes strongly sinuous, particularly on the anterior lateral margins. In one specimen there are two deep anterior sinuses with a prominent linguiform extension between. This individual has much the appearance of *P. trilobum* (*Pileopsis trilobus*, Phillips), to which the species is evidently closely allied." [Meek & Worthen.]

Position and locality: Keokuk division of the Sub-carboniferous series Crawfordsville, Ind.; cabinet of Prof. Collett.

CEPHALOPODA.

Genus GONIATITES, DeHaan.

Goniatites oweni, Hall.

PLATE VII., FIGURES 3 AND 4.

Goniatites oweni„ Hall, 13 An. Rep. Regents Univ., N. Y., p. 100.

"Shell depressed, sub-orbicular; umbilicus moderately large (varying in different individuals); volutions five, six or more; about one-sixth to one-fourth the width of the volutions showing in the umbilicus, three-fourths or more being embraced in each succeeding volution. Aperture sub-lunate or semi-elliptical, with the angles auriculate; sides of the volutions flattened toward the ventral margin; and gradually curving to the dorsal side; the back regularly curved. Surface (as preserved in the specimens examined), without markings. Dorsal lobe elongate, a little wider above than below and narrower in the middle, extremity bifid; dorsal saddle highly arched, with a height equal to, or greater than its width at base; dorsal-lateral lobe elongate, triangular, with a low arching lateral saddle and a narrow triangular ventral lobe." [Hall.]

Position and locality: Kinderhook division* of Sub-carboniferous series; Rockford, Indiana; cabinet of Prof. Collett.

CRUSTACEA.

(Trilobites.)

Genus PHILLIPSIA, Portlock.

Phillipsia bufo, Meek & Worthen.

PLATE VI., FIGURE 5.

Phillipsia (*Griffithides*) *bufo*, Meek & Worthen, Ill. Geol. Repts., Vol. IV., p. 528.

"Entire outline elliptical, the breadth being to the length as 75 to 130 Cephalic shield forming more than a semi-circle, round in front and nearly. straight behind; posterior lateral angles terminating in short, abruptly pointed spines extending back to the anterior edge of the thoracic segment. Glabella rather depressed, convex, wide anteriorly and narrowing posteriorly to the neck furrow, just in front of which, and connected with the palpebral lobes on each side, it has a single small, obscure lateral lobe; neck furrow broad and well defined, both across the glabella and across the posterior margins of the cheeks; neck segment rather wide, depressed below the level of the highest part of the glabella in front of it. Eyes of moderate size, reniform nearly as prominent as the glabella, placed but little in front of the continuation of the neck furrow across the cheeks, apparently smooth, but showing, when the outer crust is removed, numerous very minute lenses beneath. Cheeks sloping off rather abruptly from the eyes to the thickened margin, which does not continue around the front of the glabella; facial sutures cutting the anterior margin in front of the eyes before, and a little outside of them behind. Thorax nearly twice as wide as long, distinctly trilobate; mesial lobe but moderately prominent, nearly twice as wide as either of the

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*Knobstone division of Indiana Geol.

lateral lobes, its eight segments merely rounded, and without furrows. Lateral lobes narrow; pleuræ curving moderately downwards at less than half their length out from the axail lobe, but not distinctly geniculated, each provided with a furrow extending nearly half way out.

Pygidium approaching semi-circular, with the anterior lateral angles obliquely truncated; mesial lobe but slightly wider anteriorly than the lateral; segments about eleven; lateral lobes with eight or nine segments. Surface finely granular, the granules being most distinct on the glabella, and the segments on the mesial lobe of the thorax." [Meek & Worthen.]

The specimen figured on plate V. has been somewhat distorted by accidental pressure, but it is evidently specifically identical with Meek & Worthen's type of this species, which was from the same locality.

Position and locality: Keokuk division of the Sub-carboniferous series; Crawfordsville, Indiana; cabinet of Hon. John T. Scott.

COAL MEASURES.

BRACHIOPODA.

Genus Productus, Sowerby.

Productus costatus, Sowerby.

Plate VIII., Figures 7 and 8.

Productus costatus, var. Hall, Vol. I., Part II., Geol. of Iowa, p. 712.

The form represented by figures 7 and 8, plate VIII., has for many years been generally identified with the European species, *Productus costatus*, but by some it has been regarded as identical with *P. semi-reticulatus.* If really identical with either of those European species, it seems to be more properly referable to the former than the latter species. Professor Hall recognized this form in Iowa as identical with *P. costatus*, but as a distinct variety. The following is his description of it: "Shell somewhat hemispheric, transverse, about as long as wide. Ventral valve strongly arcuate, ventricose in the middle on each side, with a broad, shallow depression down the center which does not extend to the beak, constricted at the cardinal extremities below the vault, and extended in short, sometimes recurved auricles; beak incurving a little beyond the hinge-line; sides rounded, compressed, the front usually somewhat sinuate. Dorsal valve regularly concave in the middle, flattened or broadly grooved towards the hinge extremities.

Surface of ventral valve marked by numerous rounded costæ, many of which frequently dichotomise on the upper part of the shell, and often coalesce and again subdivide below; cardinal margin marked by two or three spines on each side (two often quite conspicuous on each of the ears), and a row of spines upon the fold just within the constriction bounding the ears, extending from near the beak in a curving line towards the base of the shell. Entire surface of the valve marked at irregular intervals by the bases of spines, which are sometimes numerous; upper half of shell covered by strong concentric wrinkles. Surface of dorsal valve marked by strong rounded costæ and equally strong concentric wrinkles, giving, as in the opposite valve, a sub-nodose appearance. Entire surface of both valves, in well preserved specimens, marked by fine concentric striæ." [Prof. Hall.]

Position and locality: Coal measure strata; Silver mine; Vermillion county, Indiana; cabinet of Mr. Wm. Gibson.

Genus SPIRIFER, Sowerby.

Spirifer cameratus, Morton.

PLATE VIII., FIGURE 3.

Shell usually of medium size, but sometimes quite large, sub-semicircular or sub-trihedral in outline, almost always broadest at the hinge line; the hinge extremeties often pointed and sometimes mucronate. Dorsal valve not quite so capacious as the other; mesial fold distinct, broad at the front, sometimes sharply elevated, but more commonly rounded, clearly defined from front to beak and rapidly increasing in width to the front by the greater or less curving outward of the sides; sides of the valve sloping almost directly from the mesial fold to the lateral borders; antero-posterior convexity of the mesial fold very slight from front to middle, but increasing from the middle to the beak; beak small, projecting slightly over the cardinal border. Ventral valve strongly arching from beak to front, the beak being prominent, pointed and curved over the area; area concave, of moderate width and not narrowing to a sharp angle at the hinge extremities; foramen almost equilaterally triangular, partially closed by a pseudo-deltidium, which is often removed by weathering; mesial sinus well defined from front to beak and in all respects answering to the mesial fold of the other valve.

Surface marked by numerous distinct, rounded striæ of unequal size, which increase gradually in size towards the front; striæ increasing in number by the division near the beak of the few which are continuous to its point; they are thus generally gathered into more or less distinct fascicles of three or more striæ in each fascicle, the middle striæ of each fascicle being more prominent than the others, and these are the only striæ which reach the point of the beak; the mesial fold and sinus usually have striæ of the same character and arrangement as those upon other parts of the shell, but in some cases they are obsolete upon the sides of the fold and sinus respectively. Besides the radiating striæ, the surface is marked by the usual lines and laminations of growth. The figure on Plate VIII. is of a specimen which does not show the striæ gathered into distinct groups, as is commonly the case. This is one of the most common species in the coal measure strata of North America, of which it is also one of the most characteristic fossils.

Position and locality: Coal measure strata; Waterman, Parke county, Indiana.

LAMELLIBRANCHIATA.

Genus ALLORISMA, King.

Allorisma subcuneata. Meek & Hayden. ?

PLATE VIII., FIGURES 1 AND 2.

Allorisma subcuneata Meek & Hayden, Final Report Geol. Nebraska, p. 221.

"Shell attaining a large size, longitudinally elongated, or twice to three times as long as high, the proportional length increasing with age, greatest convexity a little in advance of the middle and in the umbonal region; cuneate and a little gaping behind, where the margin is more or less narrowly rounded in outline. Basal and dorsal margins nearly parallel, the latter being more or less concave in outline, or nearly straight, and inflected so as to form a lanceolate kind of a false area, bounded by an obtuse ridge on each side, just outside of which there is a shallow, undefined sulcus; basal margin slightly convex, or somewhat straightened along the middle, and sometimes very faintly sinuous just under the beaks, rounding up more abruptly before than behind; anterior margin very short, a little gaping and rather prominently rounded below; beaks convex, incurved, and placed near the anterior end, rather depressed, but rising moderately above the dorsal margin. Surface ornamented with fine striæ of growth, and well defined concentric undulations, usually most distinct and regular on the beaks and umbonal regions.

Length of the largest specimen seen, 4.81 inches; height from ventral to dorsal margin, near middle, 1.76 inches; convexity, 1.57 inches.

This fine species has neither umbonal ridge nor lunule, properly speaking, though there is an undefined excavation in front of the beaks, and an obscure ridge extending from the back part of each beak to the posterior extremity of the hinge. Like, perhaps, all other species of this and several allied genera, this species, when well preserved, has its entire surface covered with granules. These granules are rather scattering, and, as usual, arranged in radiating rows; it is very rarely, however, that specimens are found in a condition to show these delicate surface characters, since there are usually no traces of them on casts of the shell." [Meek & Hayden.]

The specimen represented by Figures 1 and 2 on Plate VIII., is a little more elongate than is usual with *A. subcuneata*, although the apparent elongation is evidently somewhat increased by the accidental pressure which our specimen has suffered. There seems to be little room for doubt, however, that it is properly referable to that species.

Position and locality: Coal measure strata, Edwardsport, Knox county, Indiana; cabinet of Professor Collett.

GASTEROPODA.

Genus POLYPHEMOPSIS, Portlock.

Polyphemopsis fusiformis, Hall.

PLATE VIII., FIGURE 6.

Macrocheilus fusiformis. Hall, Geology of Iowa, Vol. I, part II, p. 718.

Shell elongate sub-fusiform; spire more than half the whole length of the shell; its sides nearly straight, the apical angle being about thirty degrees; volutions ten or twelve, those of the spire gently convex; the body volution moderately ventricose; suture moderately distinct but not deep. Surface marked by the ordinary lines of growth, but the shell has a rather smooth aspect.

This shell is identified with the *Macrocheilus fusiformis* of Hall with comparatively little doubt, although it is much larger than the one from which Professor Hall's description was drawn.

Position and locality: Coal measure strata, Newport, Indiana; cabinet of Professor Collett.

Genus PLEUROTOMARIA, DeFrance.

Pleurotomaria tabulata, Hall.

PLATE VIII., FIGURES 4 AND 5.

Pleurotomaria tabulata. Hall, Geology of Iowa, Vol. I, part II, p. 721.

"Shell turreted, conical; volutions about eight or nine, angular, somewhat rapidly ascending; the last one ventricose, carinate on the outer margin, with a prominent crenulate or nodiferous band, above and below which the volutions are sometimes a little concave; suture well defined; aperture transverse, somewhat ovate; columella thickened; umbilicus none. Surface marked by conspicuous striæ which are parallel to the lines of growth, bending abruptly backward on the angulated periphery of the volution; these are crossed by revolving striæ which sometimes become slightly nodulose near the sutures of the upper volutions, while on the lower side of the last volution they are more conspicuous, and are cancellated by the vertical striæ becoming nodulose at the junction." [Hall.]

Position and locality. Coal measure strata, Rush creek, Posey county, Indiana; cabinet of Professor Collett.

FOSSIL PLANTS,

Genus NEUROPTERIS.

Neuropeteris hirsuta, Lesqx.

PLATE IX., FIGURES 1, 2 AND 3.*

This species was first described in the Geological Report of Pennsylvania, and it is found widely distributed in the coal measures of North America. Professor Lesquereux speaks of it as a very polymorphous species. Figure 1 represents an ordinary large leaflet; figure 2 a smaller, similar one, showing its hirsute character, and figure 3 one of the basal leaflets placed around the stem at the point of attachment of a primary or secondary pinna. These latter leaflets are so different in character from the others of the same plant that they were formerly regarded as belonging to other genera before their true relations were known.

Position and locality: Coal measure strata; Shelburn, Sullivan county, and Spring creek, Vermillion county, Indiana; cabinets of Judge John T. Scott and Mr. William Gibson.

Neuropteris rarinervis, Bunbury.

PLATE X., FIGURES 1, 2 AND 3.

Professor Lesquereux says of this species that it "has a tripinnate or polypinnate frond; secondary pinnæ alternate, long, linear or linear-lanceolate; pinnules alternate, contiguous or distant, oblong, obtuse, cordate and somewhat dilated at the base with the exterior lobe a little extended, a little undulate on the margin; terminal pinnule deltoid, nearly trilobate; superior pinnæ simple, linear-lanceolate, pinnatified, or with slightly undulate margins, medial nerve distinct, strong near the base, veins distinct, flat, thick, bifurcate."

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*Figures 1 and 2 show a midrib in the leaflets instead of a fascicle of nervules as they should.

Position and locality: Coal measure strata from Nova Scotia to Indiana, Kentucky and Illinois.

Genus CALLIPTERIS.

Callipteris sullivanti. Lesqx.

PLATE IX., FIGURE 4.

The following is Prof. Lesquereux's description of this beautiful form: 'Frond apparently very large, and at least bipinnate; secondary pinnæ lanceolate, with a broad canaliculate rachis; pinnules alternate, oblique, ovate or oblong, nearly contiguous, slightly decurrent at the base, and united together with a slightly obtuse sinus; medial nerve broad and flat, abruptly disappearing above the middle of the leaflets; veins obliquely arched, slender, close, mostly twice forked."

Position and locality: Coal measure strata; Spring creek, Perrysville, Indiana; cabinet of Mr. Wm. Gibson.

Genus ANNULARIA.

Annularia longifolia. Brongniart. ?

PLATE XI., FIGURES 1 AND 2.

This is a variable species, but the specimen figured on Plate XI. seems to belong to the *A. longifolia* of Brongniart, or at least to the species represented by the forms found in the coal measures of the United States which have been usually referred to *A. longifolia.* The following is Prof. Lesquereux's description of the species, together with his remarks upon it:

"Stem thick, round, narrowly and equally striate, articulate, divided into opposite diverging branches placed crosswise in ascending, bearing at the articulations whorls of ovate-lanceolate, obtusely pointed flat leaflets, marked by a broad medial nerve. Upon specimens which seem to belong to the upper, still undeveloped part of the plant, the branches and leaflets are crowded and pressed upon one another in a scarcely distinguishable mass, presenting sometimes the appearance of a peculiar species of *Sphenophyllum.* On a specimen which shows the plant in its full development the stem, about one foot long, half an inch thick at the base, regularly striate in length, is articulate at the distance of one inch by whorls of leaves of the form described above, and two opposite branches diverging in open angles from under the leaves, and cross-wise in ascending. The leaflets, one inch long and one-sixth of an inch broad, twelve to fourteen in each whorl, are joined at their base. The point of attachment of the leaflets upon the stem and branches is marked around the articulation by small, semi-lunar inflations or knots, corresponding in number with the leaflets, and placed just above the point of attachment."

The foregoing description does not fully agree with the specimen figured on Plate XI., partly because of its imperfection, but our figure agrees very well with a figure of *A. longifolia* given by Prof. Lesquereux on Plate II., Figure 2, Atlas of the Coal Flora, Reports Second Geol. Survey of Pennsylvania.

Position and locality: Coal measure strata; Shelburn, Indiana; cabinet of Prof. Collett.

Genus ODONTOPTERIS.

Odontopteris subcuneata, Bunbury?

PLATE XI., FIGURE 3.

The following is a quotation from Professor Lesquereux's remarks upon this species in Vol. II. Illinois Geol. Reports: "It is somewhat doubtful if the branch of Odontopteris figured on our plate is the same as that of Mr. Bunbury. The general form of the leaflets, especially the basilar prolongation into an ear-like appendage, and also the thinness and ramification of the slightly arched and dichotomous veins, are the same."

Position and locality: Coal measure strata, Spring creek, Vermillion county, Indiana; cabinet of Mr. Wm. Gibson.

Genus SPHENOPTERIS.

Sphenopteris acuta, Brongniart. ?

PLATE XI., FIGURE 4.

The specimen figured on plate XI. seems to be identical with the *S. acuta* of Brongniart. It is rare in American strata.

Position and locality: Coal measure strata, Grape creek, Vermillion county, Illinois; cabinet of Mr. Wm. Gibson.

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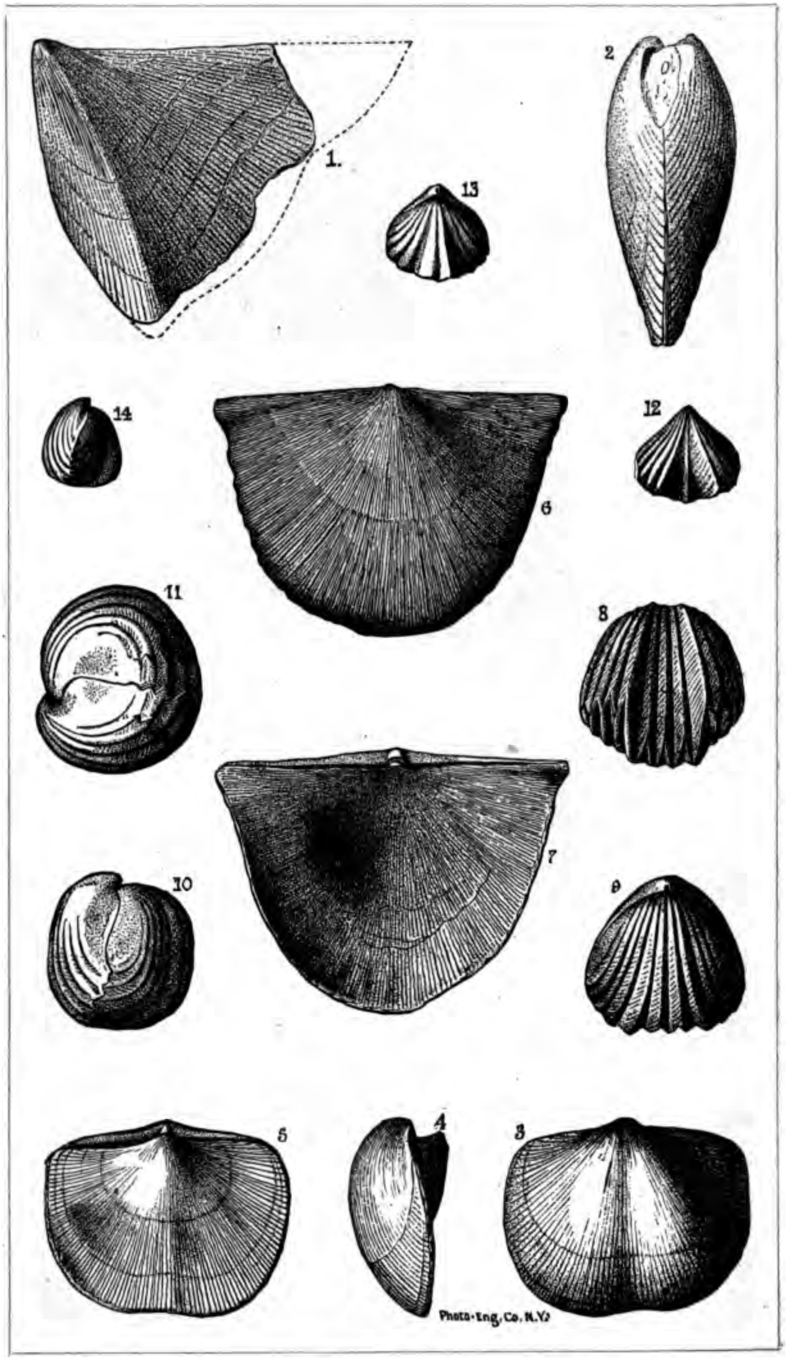
ERRATA.

On page 138, line 28, for VII, read VI.
On page 16, line 37, for Megalonix, read Megalonyx.
On page 98, line 6, for Margar, read Margaritana.

LOWER SILURIAN. PLATE I.



From pen-drawings by J. C. McConnell.

1*

EXPLANATION OF THE PLATES.

PLATE I.

Megaptera casei. p. 123.

1; Left side view of type specimen.
2; Front view of the same.

Orthis subquadrata. p. 116.

3; Ventral view.
4; Lateral view of the same.
5; Dorsal view of the same.

Strophomena alternata. p. 113.

6; Ventral view.
7; Dorsal view of the same.

Rhynchonella capax. p. 121.

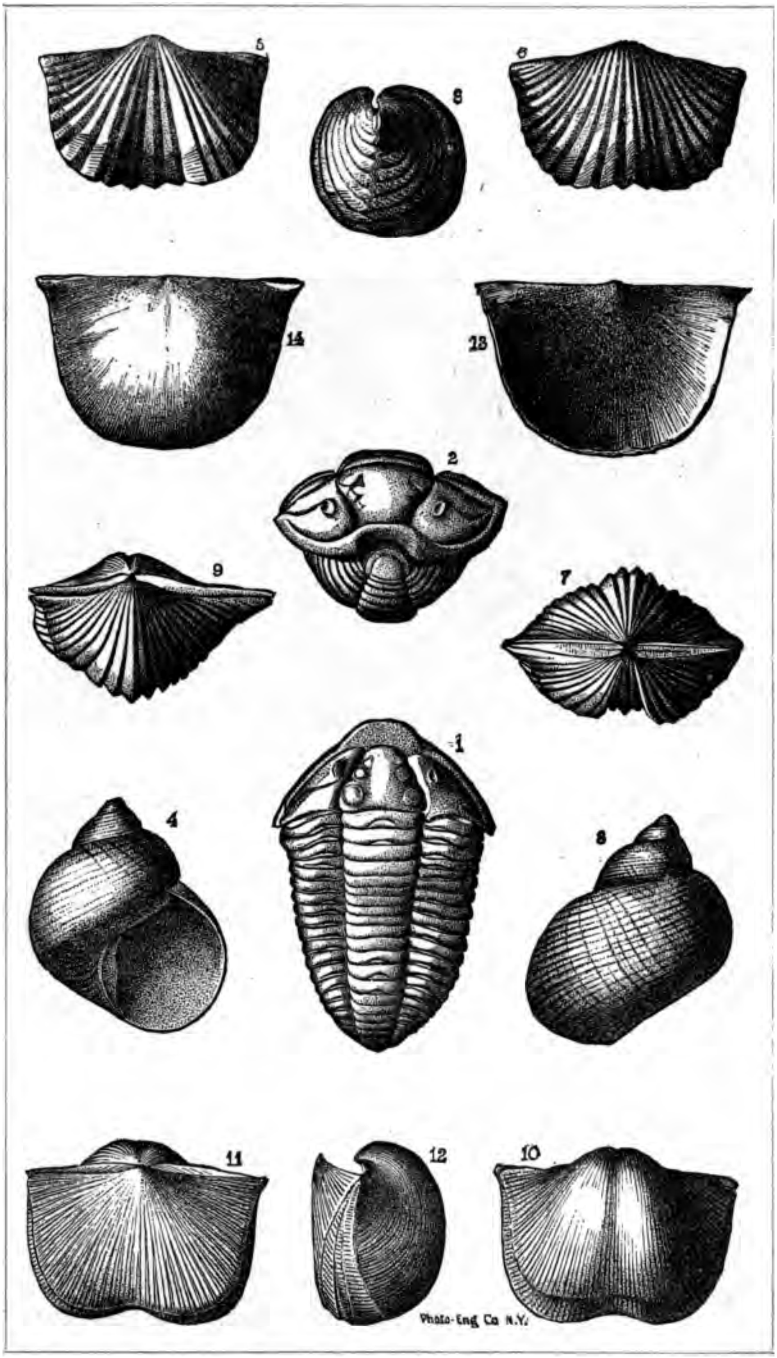
8; Ventral view of an adult specimen of ordinary size.
9; Dorsal view of the same.
10; Lateral view of the same.
11; Lateral view of an extremely gibbous specimen.

Rhynchonella dentata. p. 122.

12; Ventral view.
13; Dorsal view of the same.
14; Lateral view of the same.

All figures on this plate are of natural size.

LOWER SILURIAN. PLATE II.



From pen-drawings by J. C. McConnell.

PLATE II.

CALYMENE SENARIA.	p. 125.

1; Dorsal view of an extended specimen.
2; Front view of a coiled specimen.

CYCLONEMA BILIX.	p. 124.

3; Lateral view.
4; Apertural view of the same.

ORTHIS BIFORATA. var. ACUTILIRATA.	p. 119.

5; Ventral view.
6; Dorsal view of the same.
7; Front view of the same.
8; Lateral view of the same.
9; Dorsal view of another specimen.

ORTHIS OCCIDENTALIS.	p. 117.

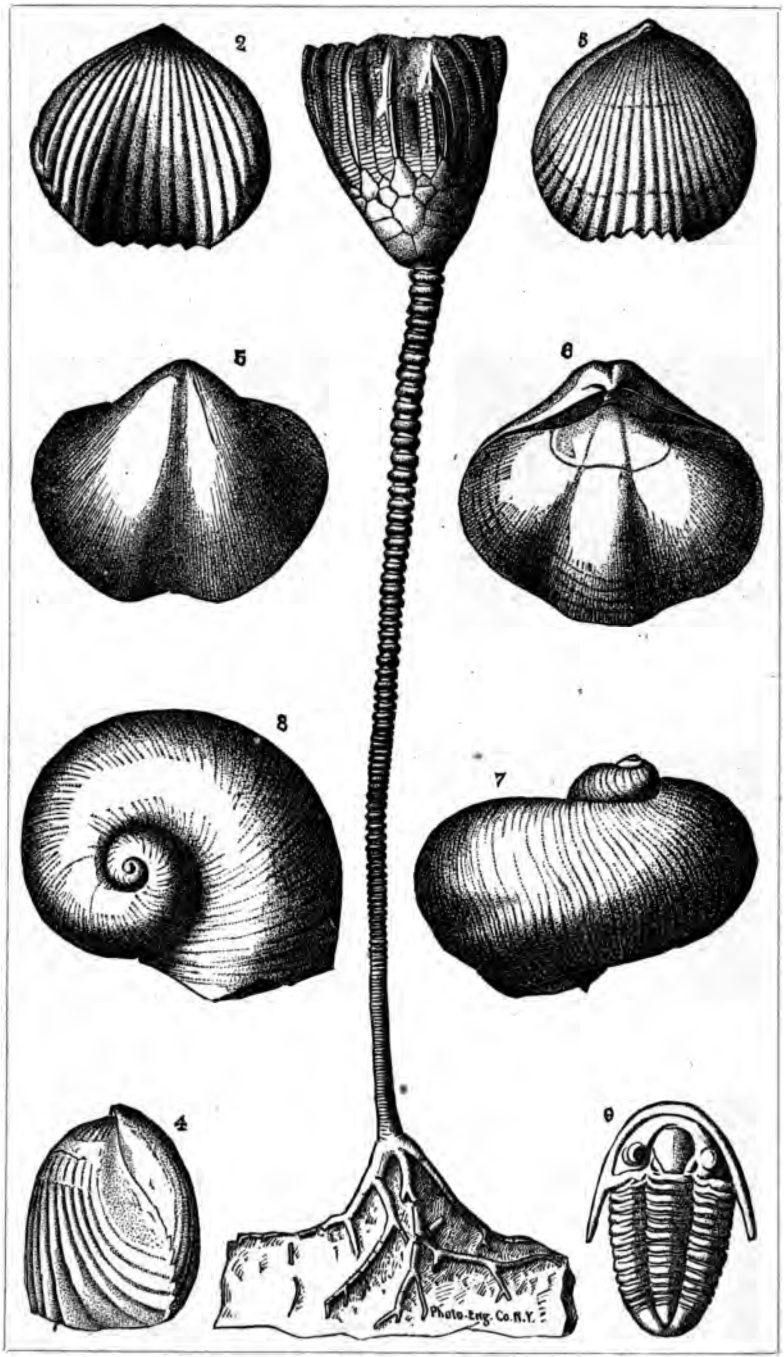
10; Ventral view.
11; Dorsal view of the same.
12; Lateral view of the same.

STROPHOMENA PLANUMBONA.	p. 115.

13; Ventral view.
14; Dorsal view of the same.

All the figures on this plate are of natural size.

UPPER SILURIAN. PLATE III.



From pen-drawings by J. C. McConnell.

PLATE III.

EUCALYPTOCRINUS CRASSUS.	p 127.

1; View of an almost entirely perfect example from near Waldron, Indiana.

RHYNCHONELLA TENNESSEENSIS.	p. 128.

2; Ventral view.
3; Dorsal view of the same.
4; Lateral view of the same.

SPIRIFER RADIATA.	p 129.

5; Ventral view.
6; Dorsal view of the same.

PLATYOSTOMA NIAGARENSIS.	p. 129.

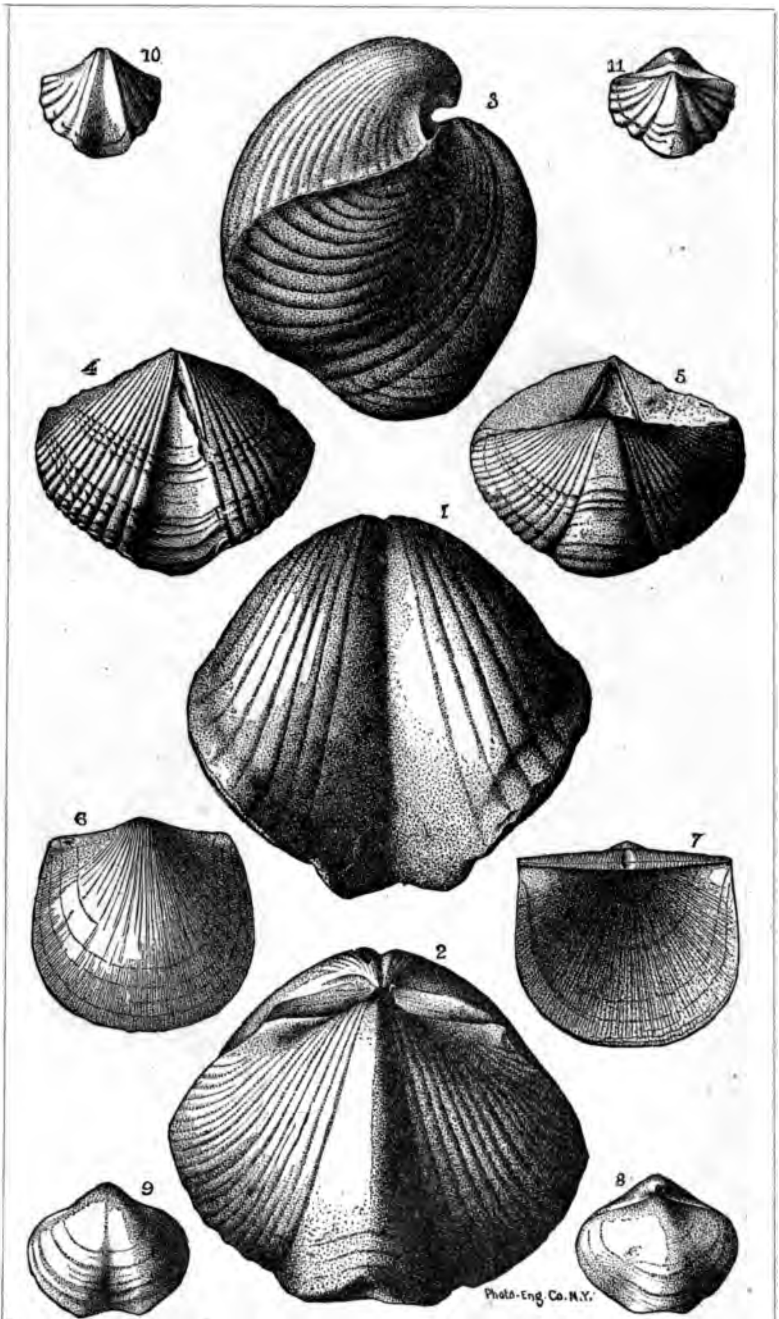
7; Lateral view.
8; Apical view of the same.

CYPHASIS CHRISTYI.	p. 130.

9; Dorsal view.

All the figures on this plate are of natural size.

DEVONIAN. **PLATE IV.**



From pen-drawings by J C McConnell.

PLATE IV.

Spirifer acuminata. p. 135.

1; Ventral view.
2; Dorsal view of the same.
3; Lateral view of the same.

Spirifer euritines. p. 136.

4; Ventral view.
5; Dorsal view of the same.

Strophodonta demissa. p. 132.

6; Ventral view.
7; Dorsal view ofthe same.

Athyris vittata. p. 134.

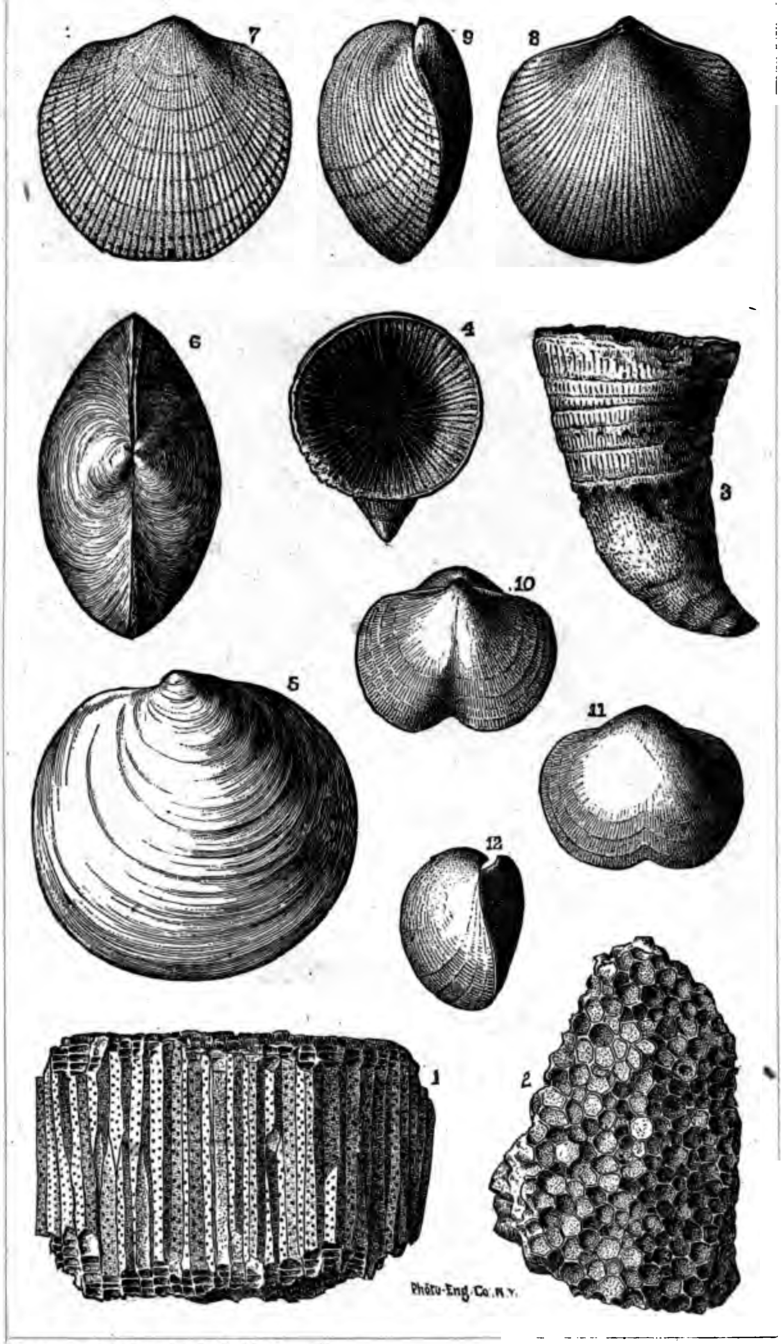
8; Dorsal view.
9; Ventral view of the same.

Spirifer gregaria. p. 136.

10; Ventral view.
11; Dorsal view of the same.

All the figures on this plate are of natural size.

DEVONIAN. PLATE V.



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From pen-drawings by J. C. McConnell.

PLATE V.

Favosites. p. 131.

1; Side view of a fragment of a corallum mural walls, tabulæ and pores.
2; Upper view of the same.

Zaphrentis. p. 131.

3; Lateral view.
4; View of the inside of the calyx of the same.

Paracyclas elliptica var. occidentalis. p. 137.

5; View of the left side.
6; Dorsal view of the same.

Atrypa reticularis. p. 134.

7; Ventral view.
8; Dorsal view of the same.
9; Lateral view of the same.

Orthis iowensis. p. 133.

10; Ventral view.
11; Dorsal view of the same.
12. Lateral view of the same.

All the figures on this plate are of natural size.

SUBCARBONIFEROUS. PLATE VI.

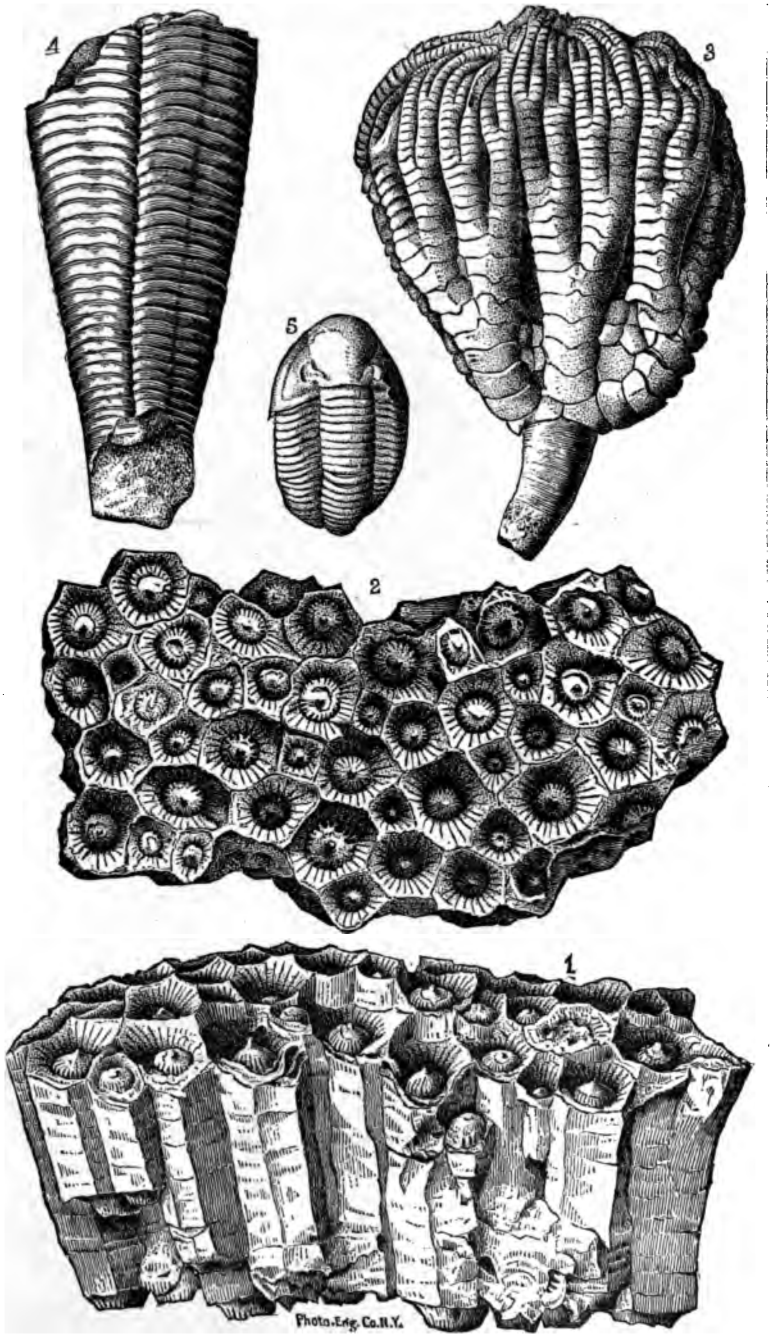

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PLATE VI.

Lithostrotion mamillare. p. 138.

1; Side view of a portion of a mass of corallites.
2; Upper view of the same.

Taxocrinus multibrachiatus, var. colletti. p. 138.

3; Anterior side view of a nearly perfect, but crushed, specimen, the flattening having produced an unnaturally broad appearance to both body and stem.

Conularia missouriensis. p. 145.

4; Side view of a portion of the shell.

Phillipsia bufo. p. 147.

5; Dorsal view of a specimen which is nearly perfect, but a little distorted by pressure.

All the figures on this plate are of natural size.

SUBCARBONIFEROUS PLATE VII.

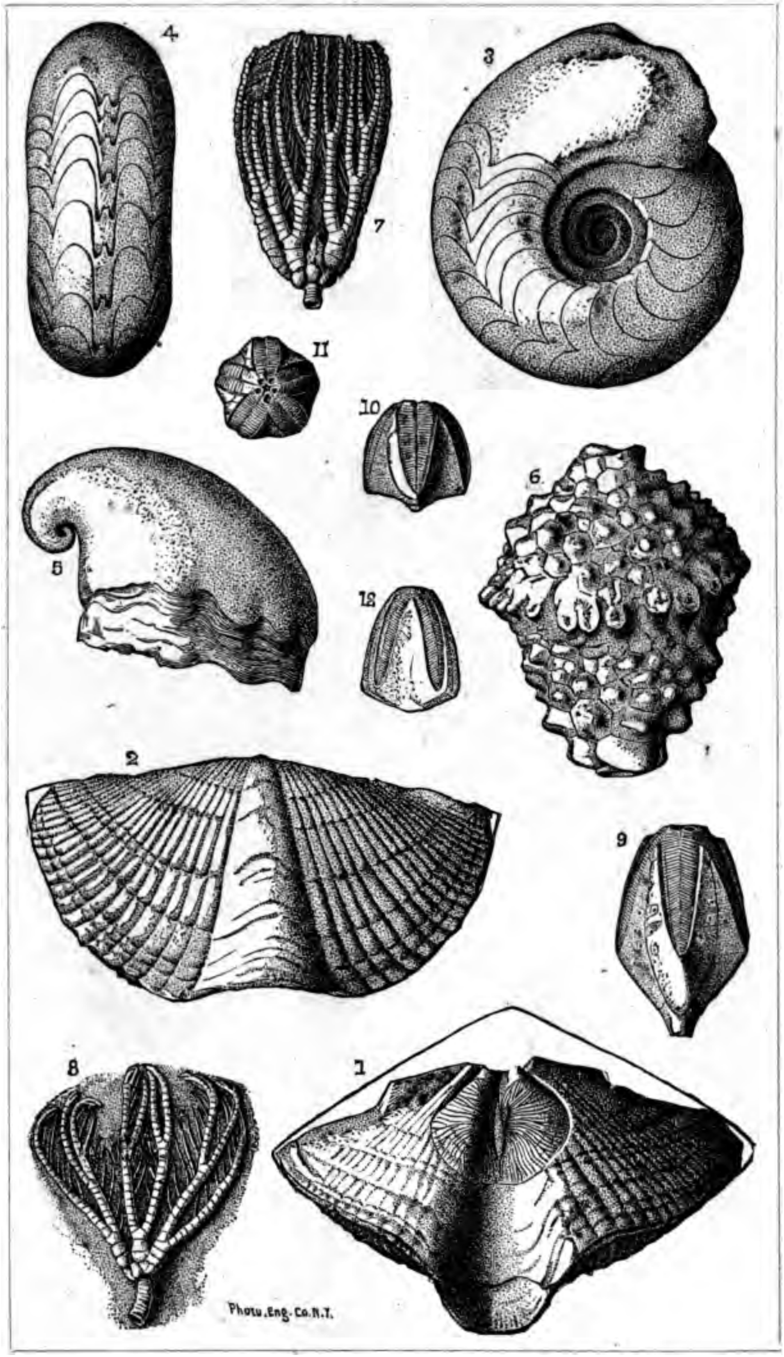

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PLATE VII.

SPIRIFER TEXTUS. p. 144.

1; View of the ventral side; the greater part of the test having been removed; showing the large muscular scar.
2; View of the dorsal valve of the same specimen.

GONIATITES OWENI. p. 146.

3; Side view of a medium sized specimen.
4; Peripheral view of the same.

PLATYCERAS EQUILATERA. p. 146.

5; Side view of a specimen of ordinary size.

ACTINOCRINUS WACHSMUTHI. p. 142.

6; Side view of the body; the arms and column removed.

SCAPHIOCRINUS GIBSONI. p. 139.

7; View of the anal side; showing arms and a portion of the stem.

SCAPHIOCRINUS GURLEYI. p. 141.

8; View of the anterior side; showing arms and a portion of the stem.

PENTREMITES PYRIFORMIS. p. 143.

9; Side view. The spots upon the surface are due to a partial silicification of the specimen.

PENTREMITES GODONI. p. 143.

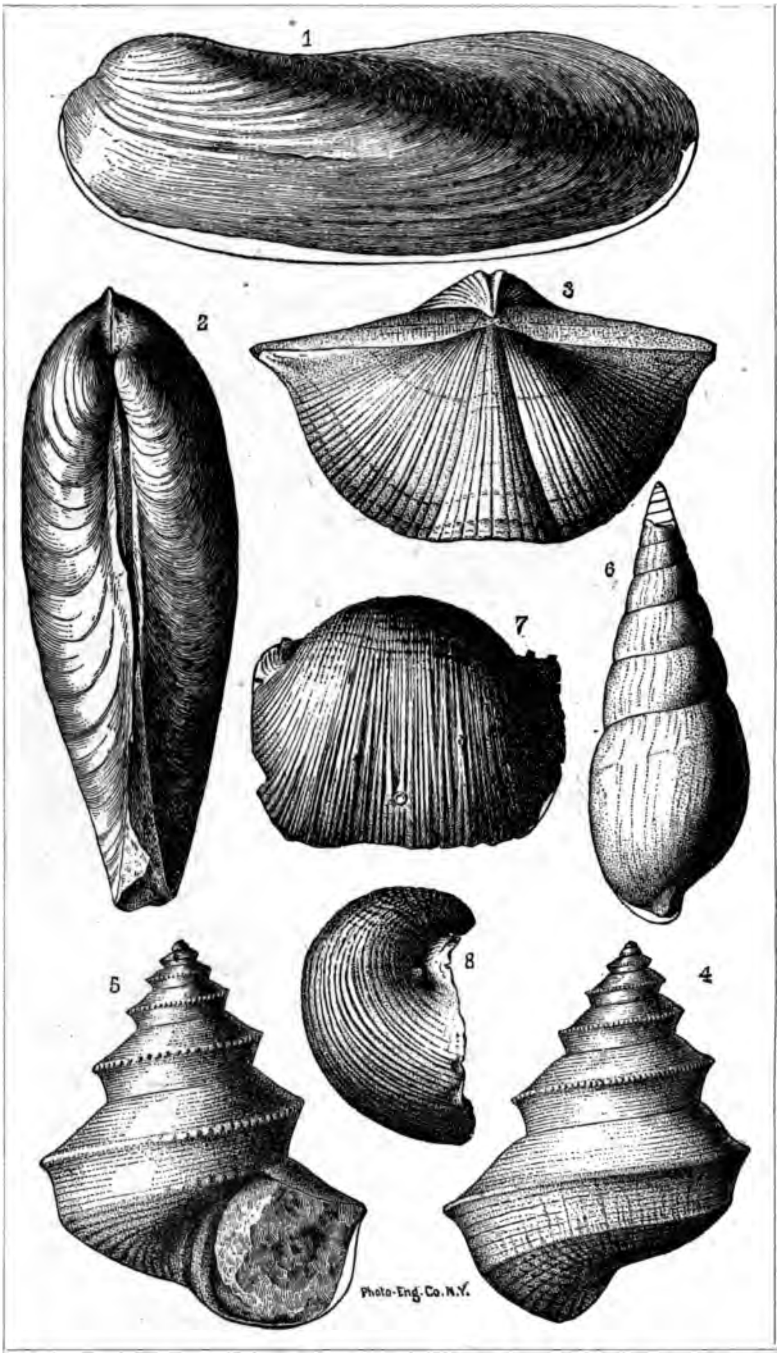
10; Side view of a specimen a little less than average size.
11; Summit view of the same.

PENTREMIES CONOIDEUS. p. 144.

12; Side view of a specimen of ordinary size. Some specimens are rather more elongate.

All the figures on this plate are of natural size.

COAL MEASURES. PLATE VIII.



From pen-drawings by J. C. McConnell.

PLATE VIII.

ALLORISMA SUBCUNEATA?	p. 150.

1; Side view of a specimen that has been somewhat distorted by vertical pressure.
2; Dorsal view of the same.

SPIRIFER CAMERATUS.	p. 150.

3; Dorsal view of a specimen of ordinary size. This figure is of a specimen upon which the radiating striæ are not gathered into distinct groups, as is commonly the case with this species.

PLEUROTOMARIA TABULATA.	p. 151.

4; Lateral view of a rather large specimen.
5; Apertural view of the same.

POLYPHEMOPSIS FUSIFORMIS.	p. 151.

6; Lateral view of a large example.

PRODUCTUS COSTATUS var.	p. 148.

7; Ventral view of a rather large specimen.
8; Lateral view of the same.

All the figures on this plate are of natural size.

COAL MEASURES. **PLATE IX.**

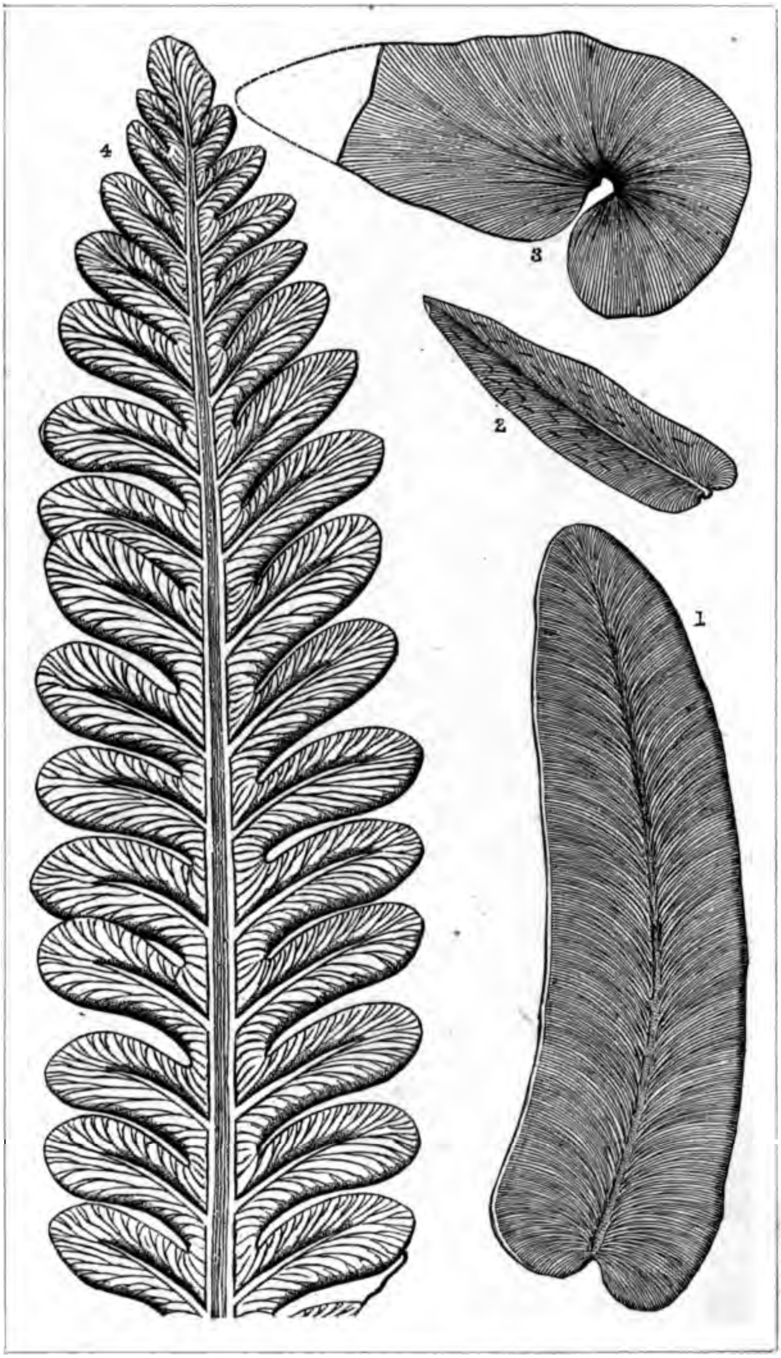


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PLATE IX.

NEUROPTERIS HIRSUTA. p. 152.

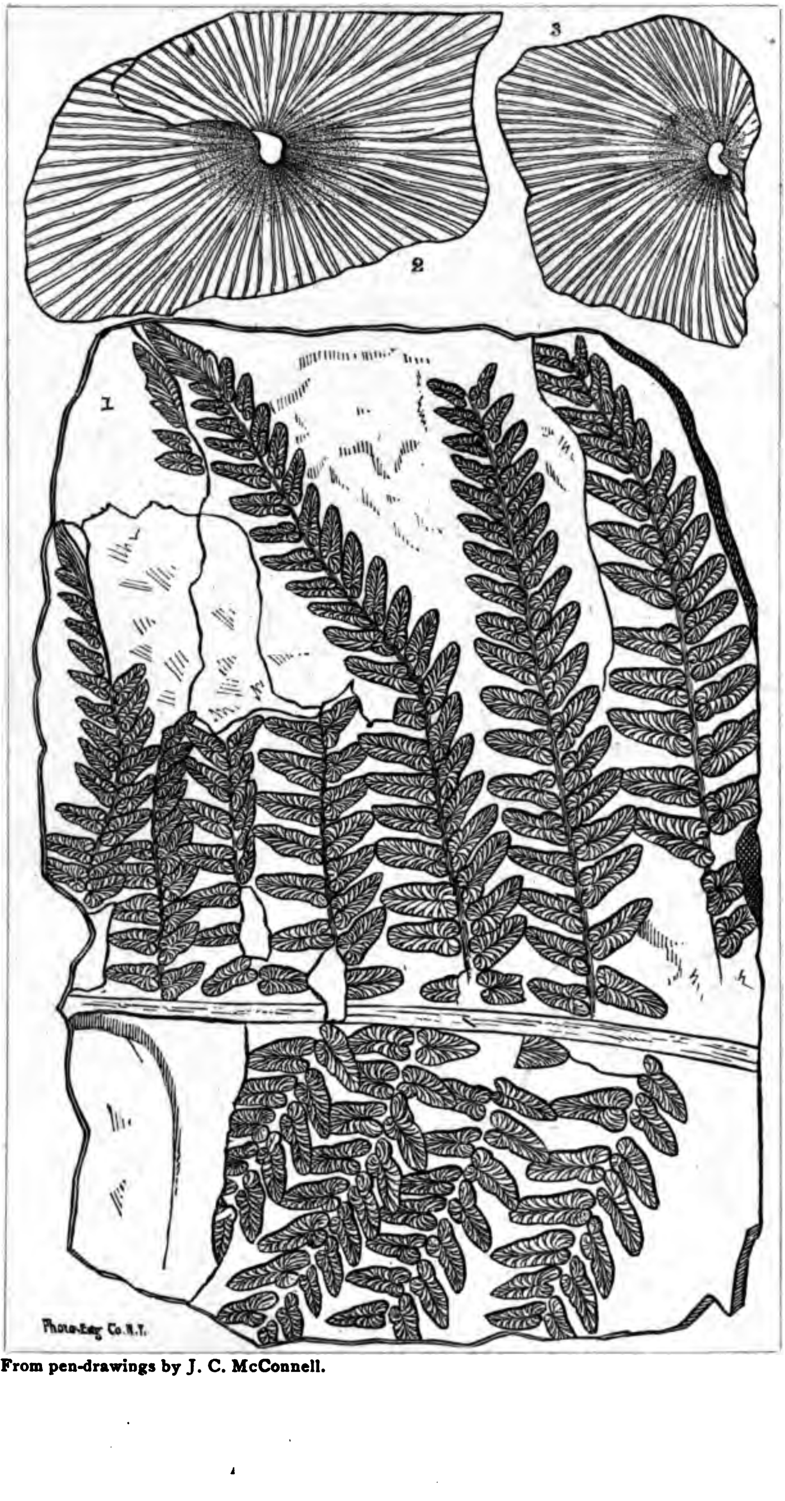
1; A large leaflet of ordinary kind.
2; A small similar leaflet, showing the hirsute character.
3; A large irregular leaflet of this species; but which was formerly referred to the genus *Cyclopteris* as *C. obliqua,* Brgt.

CALLIPTERIS SULLIVANTI. p. 153.

4; A part of a large frond.

All the figures on this plate are of natural size.

COAL MEASURES. **PLATE X.**



From pen-drawings by J. C. McConnell.

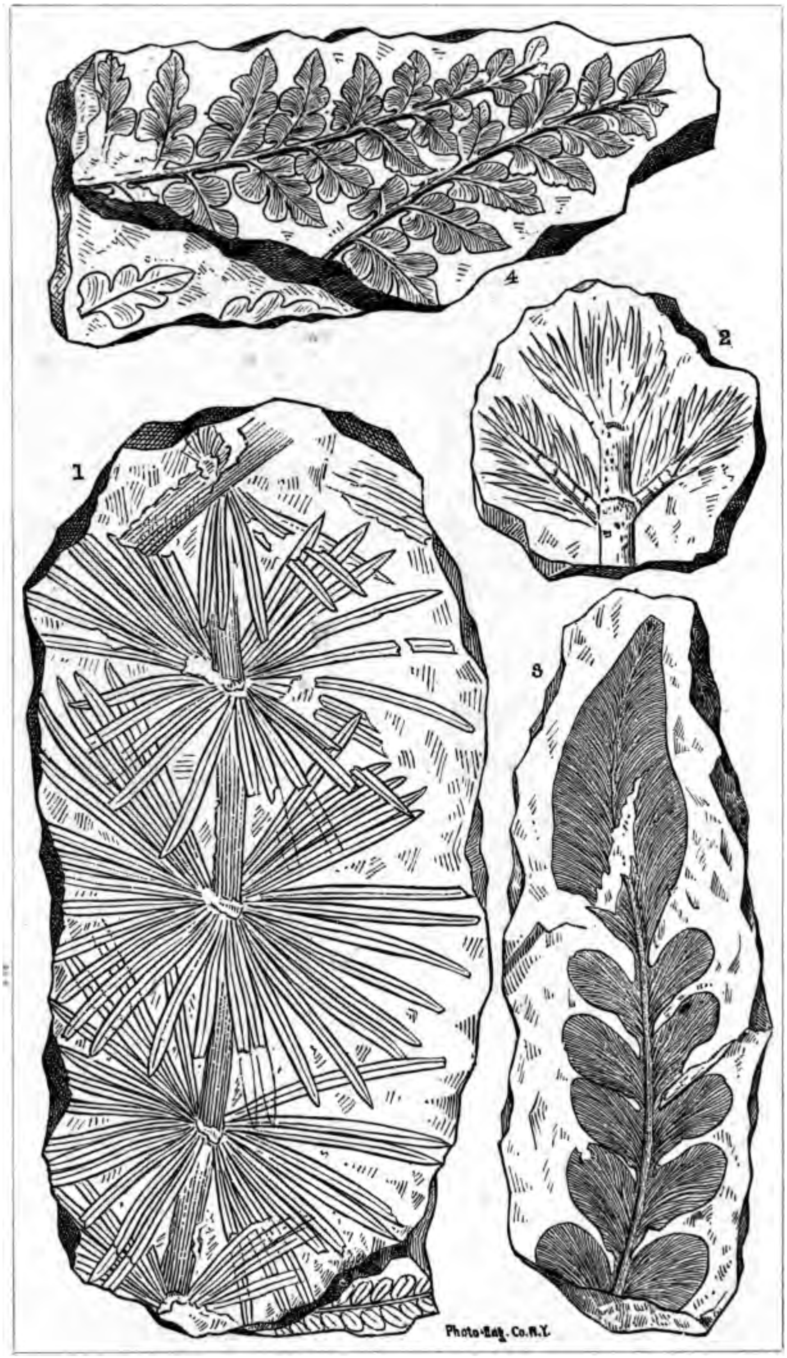
PLATE X.

NEUROPTERIS RARINERVIS. p. 152.

1; Part of a large compound frond.
2; Fragment of a large stem and leaflet of the same species, but which was formerly placed in the genus *Cyclopteris* or *Nephropteris.*
3; Another fragment of a large leaflet, similar to Figure 2.

All the figures on this plate are of natural size.

COAL MEASURES. PLATE XI.



From pen-drawings by J. C. McConnell.

PLATE XI.

ANNULARIA LONGIFOLIA. p. 153.

1 Portion of a stem bearing three whorls of leaflets and part of another.

2; A fragment showing extremities of branches with the leaflets in undeveloped whorls.

ODONTOPTERIS SUBCUNEATA. p. 154.

3; Portion of a frond.

SPHENOPTERIS ACUTA. p. 154.

4; Portion of two branches.

All the figures on this plate are of natural size.

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